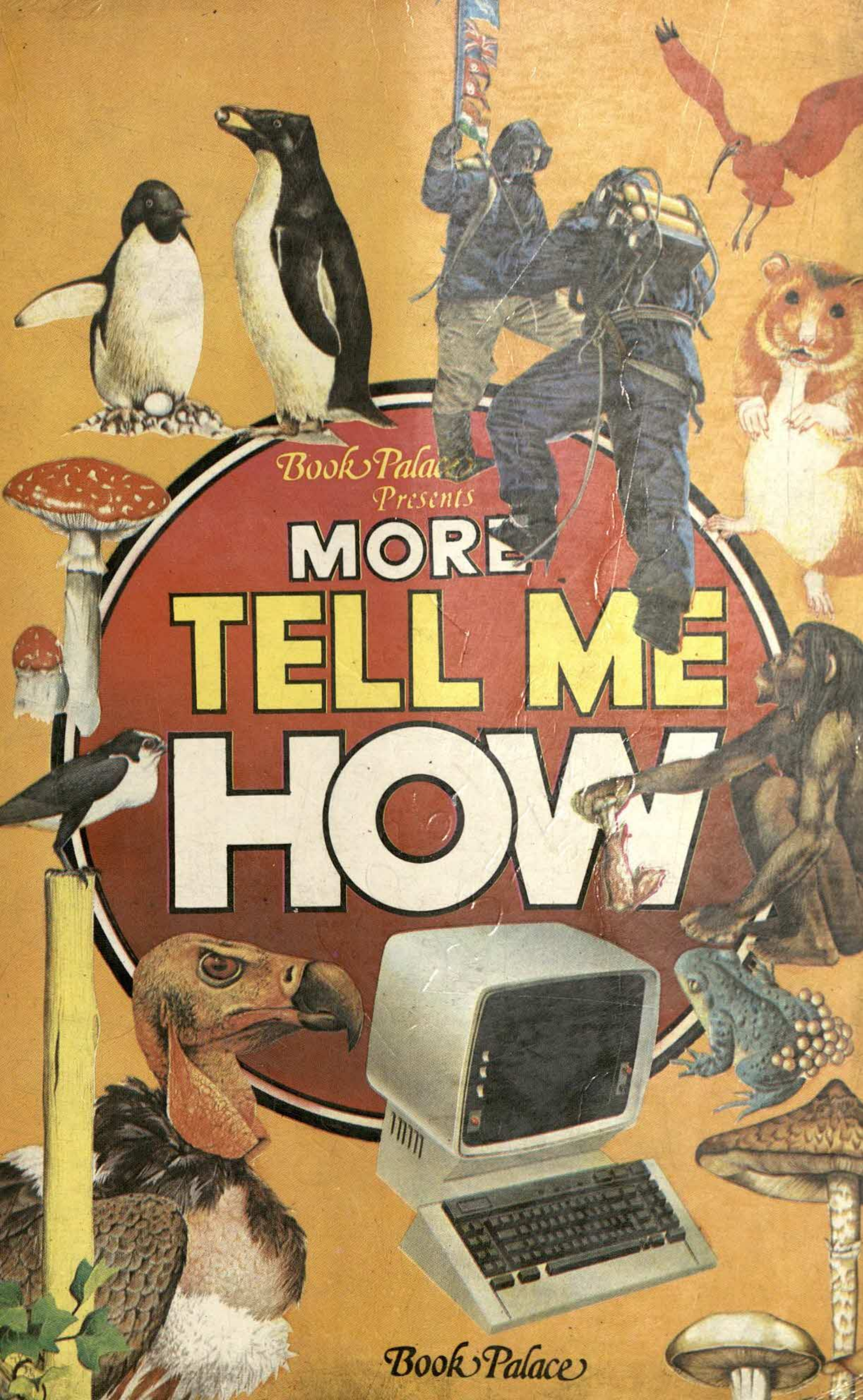

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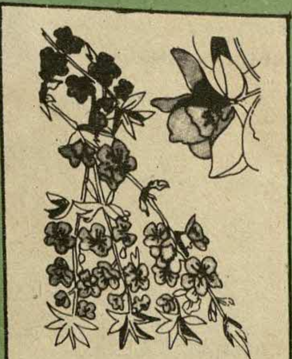

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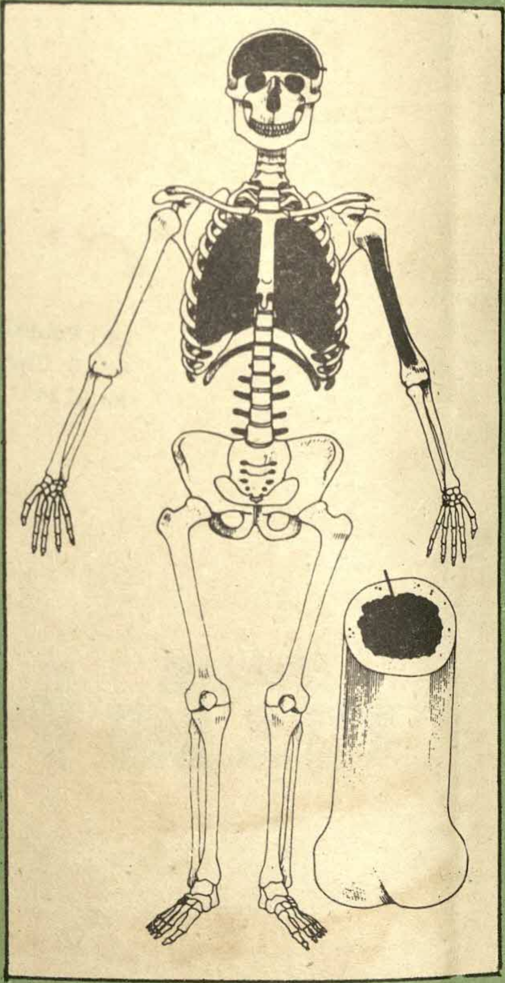

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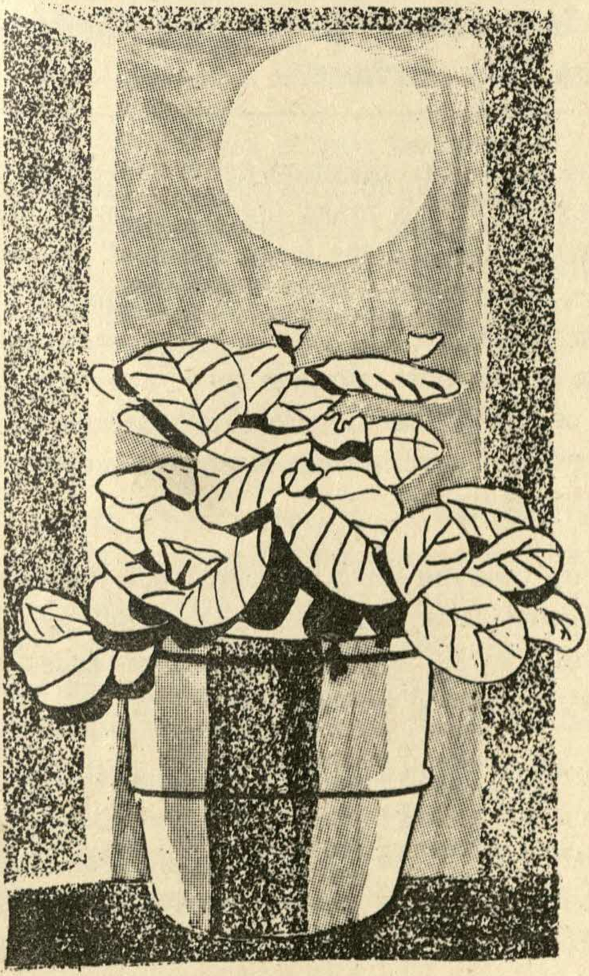
Chapter 1

The World Around Us

What makes most plants green?

Green plants owe their colour to a pigment called chlorophyll. This substance absorbs sunlight. It converts this light energy into chemical energy, which is stored in the plant and released as oxygen. It is



this process, called photosynthesis, that supplies the atmosphere with most of its oxygen. Without green plants, there would be no life on earth.

If you have plants in the house, it is important to make sure they are in a position where they will get sunlight.

Why is there more sea than land on the earth's surface?

The answer to this question lies in the composition of the rocks which make up the outer portion of the earth's crust. Over large areas of the earth's surface, these rocks are lightish in colour, relatively light in weight and are called granitic rocks, because granite is the most common type. Over still larger areas of the earth the rocks are darker, heavier and are called basaltic rocks, since among them basalt is the chief type.

We know that the earth at a depth of a few hundred miles below the surface is molten and that the surface or crustal rocks, which are about 50 miles thick, are really floating on this liquid core.

The granitic rocks stand higher than the basaltic, just as a cork floats higher than wood, and therefore the granitic areas are the continents, and the basaltic; the ocean basins. If all crustal rocks were of the same composition, the earth's surface would be one vast ocean, more than a mile deep.

But why is there water in the sea? There are three reasons. First, molten rock holds much more water than when it hardens and cools. So, as the earth's crust solidified, it gave off water vapour into the atmosphere. Secondly, the earth's gravity stops this vapour from escaping into space , just as it also retains the atmosphere we breathe. Thirdly, the pressure-temperature relationships on earth are such that the vapour is mainly in liquid form.

The water in the sea is salty because of the 2,000 million-years-old disintegration of the earth's crust. The soluble materials or salts remained in the ocean. The insoluble materials have formed sedimentary rocks and the ocean sediments.

What is mist, fog and smog?

Mist occurs when warm, moist air cools and the moisture is condensed. Sometimes this falls as dew, but at others, such as still evenings, it remains in the air as mist, because the fine water particles are too small to be affected by gravity. Fog is similar to mist, but it is much denser, and more dangerous as visibility is much less. Smog is when fog becomes mixed with smoke of carbon-dioxide fumes from car engines, to form a thick, dirty-smelling atmosphere. Smog is now being controlled in many urban areas by the use of smokeless zones, but the problems of exhaust fumes still exist.

Where is the land of the midnight sun?

The land of the Midnight Sun is the poetical name for Norway.

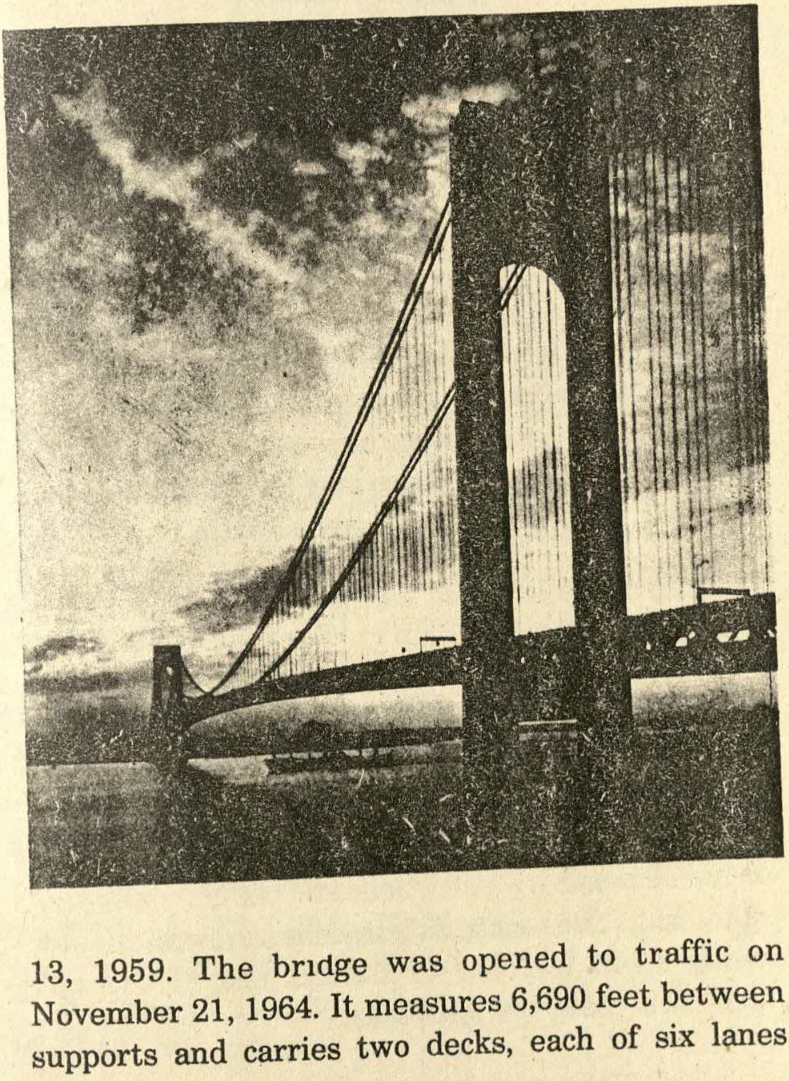
In that country from the end of April to the middle of August there is no real night darkness, but a long twilight. In the most northern part, the sun never sets completely for about two months in the summer.

In winter, however, the most northern inhabitants are not so lucky. They have no sun for two months and have to eat their lunch in twilight.

Where is the world's longest bridge?

To measure the longest bridge in the world is not as easy as it may seem. After all, there are many different kinds of bridge. Another problem is: how do you start to measure a bridge? From its supports or simply the distance it covers over ground or over water? There are many alternatives.

The bridge with the longest span is the Verrazano-Narrows Bridge, which stretches across the entrance to New York City from Staten Island to Brooklyn. Work on the project began on August



13, 1959. The bridge was opened to traffic on November 21, 1964. It measures 6,690 feet between supports and carries two decks, each of six lanes of traffic.

The centre span over water, is 4,260 feet, the world record. The bridge carries well over 20 million vehicles a year.

Where are we in space?

We know that we live on the Earth. The Earth is a ball. It is a planet. All the planets going round the Sun make up the Sun's family. The Sun's family is called the solar system. The solar system is a small part of a big group of stars, known as a galaxy. We call our Galaxy the Milky Way. The Milky Way is just one galaxy in a whole host of others in the Universe. No one knows how many galaxies there are in the Universe. There may be many other solar systems. There may be many planets like Earth.

We can write a 'space address' to show where we live in the Universe.

Why does Ayer's Rock change colour?

The colour of Ayer's Rock alters continually according to the atmospheric conditions and the changing angle of the sun. The rock is an immense sandstone boulder rising 1,143 feet out of the flatness of the plain near the centre of Australia.

It is normally red, and measures over five miles round the base with relatively gentle slopes which can be easily scaled. The most dramatic effects occur at sunrise, when the sun's rays inflame the rock to a burning crimson, and at sunset, when marvellous purple shadows overlay the glowing blood-red monolith. The colours of the rock vary from a yellowish-ochre through all the various shades of oranges and reds to a deep purple and to black.

Ayer's rock is now one of Australia's most popular tourist attractions, though visitors of one kind or another have been travelling far for centuries to see the massive shape. There was a time when it was regarded with great awe as a religious shrine. People from the local tribes came to the caves around its base to worship and to decorate the walls with paintings. The rock was discovered by an Englishman, W.G. Gosse, in 1873 and named after Sir Henry Ayers, then Prime Minister of South Australia. The spot was so remote and inaccessible that for years few people ever visited the rock. Now they come by car and aeroplane and the rock forms part of the Ayer's rock - Mount Olga National Park, 487 square miles in area, where the local plant and animal life is strictly protected.

Desert oak, mulga, mallee, bloodwood and spinifex are some of the exotic names of the plants that grow here. No less strange are the names and appearance of the animals - kangaroo, wallaby, bandicoot and euros.

Why does night fall?

The sun is really a shining star. Although it is about 150 million kilometres away, it is still closer to the

Earth than any other star. The sun is near enough to light up the whole sky around us. When the sun's light shines onto our part of the Earth, we do not need candles or electric lights to help us see. There are millions of other stars in the sky. Some are much larger than the sun. But they are all so very, very far away from us that we only see them as tiny pinpoints of light twinkling in the distance.

Although it seems flat, the sun is actually round. We know that the Earth is round like a ball, too. Both balls spin around and around in space.

The sun takes nearly one month to spin around once. It always looks the same to us whichever way it is facing. The Earth takes one day and one night to spin around once.

The Earth has no light of its own. It is lit up completely by the sun. On the half of earth which faces the sun, it is day. On the dark half of the Earth, it is night.

Do plants sleep at night?

Even plants sleep, not because they are tired and need to recover as we do, but because there is no light at night.

Plants need sunlight for life and growth. When the

Sun is shining the heads of the flowers open up to receive as much of the energy as possible. When the Sun sets the flowerheads close to avoid heat loss. You can prove this if you take a plant from a warm, light room into a cold dark one. The petals will close up. Back in the warm they will open again.

Why do stars shine?

In the Universe there are many suns like the one which lights and heats up the Earth and the other planets in our solar system. These suns are known as stars. Just like our Sun, they produce their own light as they burn themselves up.

Their brightness reaches us in the form of small points of even light because they are so far away. Their distance from the Earth is so great that we need a special unit to measure it. This is known as a light-year: that is, the distance that light travels during one year in space.

What are Kew Gardens?

The Royal Botanic Gardens are at Kew, in Surrey. Originally they were a nine acre botanical estate owned by Princess Augusta, widow of Frederick, Prince of Wales. Princess Augusta's son, George III, lived at Richmond Lodge nearby and later its land was to form the basis for Kew Gardens as we know it today. The Gardens were given over to the public in 1841, and in 1897 Queen Victoria gave the semi-uncultivated pastures of the Queen's Cottage to the Gardens. Today there are about three hundred acres of vast conservatories and botanical museums at Kew.

Why does Venice have so many canals?

Unlike most canals, those in Venice are not man-made. If anything, man has made the land round the canals.

In the 7th Century this North Italian town was no more than series of tiny islands and mud flats. After the fall of the Roman Empire, political exiles sought refuge in the Venetian lagoons. Gradually a town emerged with many of its buildings having been constructed directly over the water, supported by massive foundations on the sea bed.

The canals between the groups of houses were left, and consequently, the only form of transport in Venice today is by boat.

The vibrations of motor vehicles would soon shatter the foundations of this beautiful city, which in some cases are precariously poised on nothing firmer than

sand. In the days of the gondola all seemed well, but the wash produced by motor boats has greatly weakened Venice's structure.
To add to this historic city's problems, much of the main island is slowly sinking into the sea, largely because of the dredging and water pumping activities of a nearby industrial area.

The Italian government has now embarked on the difficult project of trying to keep this marvel of medieval and renaissance architecture and engineering afloat.

Where are the Victoria Falls?

These famous falls, among the most spectacular in the world, are on the boundary between Rhodesia and Zambia in southern Africa. The falls form the most remarkable feature of the Zambezi River. They are midway up the Zambezi near the town of Livingstone, which is named after David Livingstone, the Scottish missionary and explorer, who discovered the falls in 1855.

For some distance before the Victoria Falls the Zambezi flows over a level sheet of basalt - a hard, blue volcanic rock - in a valley between sandstone hills. Curiously, the Zambezi does not increase its speed of flow as it nears the mighty falls. The water pours over an almost vertical precipice, nearly a mile wide, at a rate of between four million and 75 million gallons a minute, depending on the season. The minimum flow is between November and December and the maximum between April and May.

The Victoria Falls are wider than Niagara Falls and more than twice their height. At the highest point the water plunges 355 feet.

The only outlet for this vast force of water is a narrow channel cut in the opposing barrier wall near its western end. The river is forced through this narrow, 100-foot gorge for nearly 400 feet. This part of the Falls is aptly known as the Boiling Pot.

From the Boiling Pot the water emerges into an enormous zig-zag which forms the beginning of the Batoka Gorge, about 60 miles long.

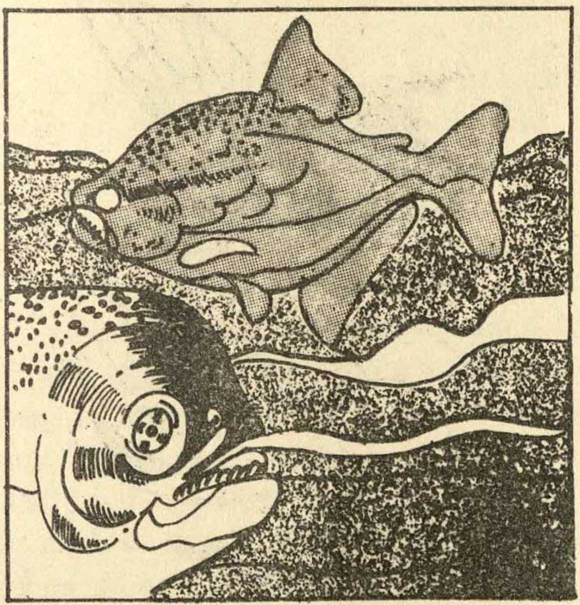
At one time it was thought that these fantastic falls were the result of a volcanic fault in the earth. Now it is believed they are caused by the check on the natural erosion of the river bed provided by the hard basaltic rock sheets.

Clouds are often helpful in weather-forecasting. What are the main types?

There are Cirrus, Nimbus, Cumulus and Stratus clouds. Cirrus are sometimes known as 'mare's tails' - they are thin and wispy. Lying as high as 30,000 feet, they are ice-clouds and usually signal a depression, and rain. Nimbus are dark, full rain-clouds. Nimbus means 'rain-bearing'. Cumulus are the piled-up, cotton-wool clouds. Stratus are layered clouds, which do not necessarily forecast rain. Many clouds combine these different types: for instance, there are Cumulo-Nimbus, Cirrus-Stratus and Nimbus-Stratus cloud formations.

Why are piranha fish dangerous?

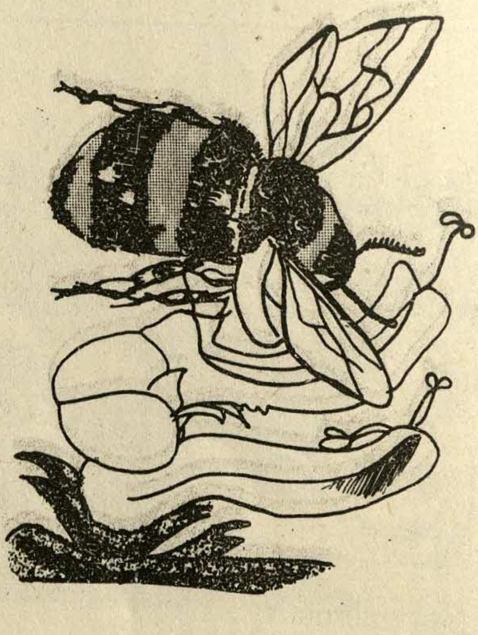
Although they are usually small-not more than 25 centimetres (8 inches) long - piranha fish are some



of the fiercest predators of rivers and seas. They live in tropical waters such as the Amazon and Orinoco Basins, and their mouths are full of sharp, pointed teeth. They swim in large numbers which make them terrible enemies, as a shoal of piranha fish can devour much larger creatures in a few minutes.

Why are insects attracted to certain flowers?

Flowers are fertilised by pollen and the pollen is often transferred to the ovule (to make the seed) by insects. The bright colours and scent of the flowers attract the insects.



There is a type of orchid which looks so much like the female of certain insect that the male insect is attracted to it and tries to mate with it. Of course, in doing this the insect pollinates and fertilises the flower. So we can see that the shape, colour and scent of flowers are not just accidental; they have a very specific purpose.

Where is home to many favourite wild animals?

The African bush, with its rich grassland and scattered water holes, provides an ideal home for many animals. Some, like the antelope, are herbivorous; they eat grass, grazing together in large herds.

Others, like the lion, are meat-eating or carnivorous. They prey on grazing herds for their food. Hyenas and jackals are scavengers. They wait for the remains of the lion's meal.

The elephant is the largest animal that lives on land. It uses its trunk like a giant hand to scoop up grass and thrust leaves into its mouth. Elephants and lions live quite peaceably together. Only on rare occasions does a lion attack an elephant.

The giraffe is the tallest of all the animals. It uses its long neck to reach leaves on the tree tops. Its strong legs allow it to make a quick getaway, when it spots a hunting lion.

The zebras rest peacefully with the wildebeestes and gazelles. They are all alert to the approach of a hungry lion.

The rhinoceros has two big horns made of matted hair. The front horn is sometimes over one metre long. It uses its horn to root for food in the ground. When it charges an enemy, the rhino lowers its horn threateningly.

Flocks of pink-winged flamingoes line the shores of lakes. They search for shellfish and water plants in the mud flats, scooping them out with long curved beaks. They are ready to fly off at the sight of a lion.

In the heat of the day, the hippopotamus basks in rivers and shallow lakes. At night, it feeds on water plants and goes ashore to graze.

How much do we know about space?

Astronomers have found out a lot about the stars. They know how far off the stars are and what makes them shine. Astronomers can explain the things in the sky that puzzled ancient people.

But we do not know all the answers. Astronomers do not know whether space ever comes to an end.

Perhaps we could never reach the edge of the Universe. It may go on and on forever. Astronomers still do not know how the Universe came to be. These are some of the things that puzzle astronomers. We do not know much more about such things than the ancient Greeks.

How long can a cactus live without water?

Plants such as cacti can survive in the desert for several years without rain. They need water just like any other plant, but have become adapted to a dry environment. They don't have leaves, which lose water rapidly in the heat. Their thick stems act as containers or reservoirs to store water against drought (when there is no rain for long periods.) Also, the cactus has wide, shallow roots, extending for a great distance around them, to trap as much rain as possible from the occasional storms.

If you have cactus plants at home they will survive even if you forget to water them for several weeks; but if you want them to grow and flower they will need some water and plant food.

Why do clouds have different shapes?

Clouds vary in shape according to their height and temperature, and they contain minute drops of water or ice particles or a combination of both. And, of course, their formation is greatly affected by wind changes.

There are basically three groups of clouds: high clouds between 17,000 and 45,000 feet (cirrus, cirro-cumulus and cirro-stratus); middle clouds between 7,000 and 23,000 feet (alto-cumulus, alto-stratus and nimbo-stratus); and low clouds up to 7,000 feet (strato-cumulus, stratus, cumulus and cumulo-nimbus). Their height and temperature decide how much pressure is exerted on them by the atmosphere.

Finally, the shapes of clouds differ according to the time of day. Towards evening clouds tend to thin out, rise a little and flatten out.

Are mute swans really silent?

The mute swan is a more or less silent bird, hence its name. It is a magnificent creature, widespread in Europe and North Asia, and is one of the heaviest bird able to fly, sometimes reaching weights of over 40lbs. Its graceful wing-span is between 7 and 8 feet, though one famous swan, known as 'Guardsman' attained a recorded wing span of 12 feet! Mute swans live in pairs for many years, building large nests and laying between 8 and 10 eggs, which hatch as grey cygnets. The birds usually get their stunning white plumage by the age of two.

Why are there different kinds of soil?

The basic material of the surface of the earth is solid rock, and the surface of the landscape we see is nearly always the result of weathering, the action of sun, wind, frost, rain, ice or snow. Therefore, there are many kinds of soil depending upon the climate and the type of parent rock. There is also a third factor which influences the kind of soil formed. This is the vegetation.

The first step in weathering is the breaking down of the rock. Water plays an important part at this stage, either by freezing and shattering the rock as it expands or by washing away some of the minerals of which the rock is composed, thereby loosening its particles.

The climate is also important for most rocks contain much quartz as well as silicates. In a cold climate, the crystals of the silicates are dissolved more quickly than the quartz. In a hot moist climate however, the quartz is washed away and the silicates left behind. Every intermediate stage can be found between these two extreme types of soil.

Vegetation also plays its part by splitting rocks with its roots. Also dead branches and leaves fall on to the ground, decay and add a layer of humus to the soil, rich in nutrients which enable larger plants to grow. These larger plants support animals, some of which help to mix the soil still further.

There are other types of soil such as those formed from the silt deposited by rivers - alluvial soils - or where bogs and marshes occur. But one thing is common to all soils. They are very unstable if the vegetation which covers them and aids in their formation is removed. Then they are easily washed away and the result of centuries of slow development is lost.

Why are some wells called artesian wells?

Artesian wells are those from which water flows freely. These wells are man-made and are created by boring into the rock to a channel that is lower than the water source.

The resulting artesian well has the advantage over vertical wells of not requiring a pump. The water will pour out naturally without the aid of any mechanism until the well runs dry. For this reason artesian wells, although often several hundred feet deep, may be only a few inches wide. This prevents undue loss of water.

The term "artesian well" is derived from **Artesium**, the ancient name for Artois in Northern France, where a famous free-flowing well was excavated early in the 12th Century.

What is an extinct volcano?

Paricutin has not erupted for more than twenty years. It is a sleeping, or dormant, volcano. Although it may erupt again one day, it is quiet for the present.

The cone-shaped pile of dust and ash around the top of the vent has blown inwards, blocking the opening. The walls of the vent itself have collapsed under the weight of rocks and ash above them. The wind has smoothed away the sides of the volcano, and rounded them into a gentle, sloping hill. The top of the volcano now looks like a large, shallow dish.

When a volcano has ceased to erupt completely, it is called an extinct, or dead, volcano. Sometimes the top of its cone may collapse after a very violent explosion, causing the crater to become much wider, like a huge, shallow basin. Living things will begin to grow and flourish on the mountain slopes.

The rounded, shallow bowl of the crater is sheltered by its high, lava wall. Some craters slowly fill with rain water and become beautiful lakes. The lakes glow with strange colours from the minerals in the rocks which dissolve in the water.

In East Africa, the volcano Ngorongoro has been extinct for thousands of years. Thorny trees and grassland fill the crater and many animals graze there and bask in the sun.

What stars are made of?

Stars are made mostly of a very light gas. This is called hydrogen. Balloons are sometimes filled with hydrogen. If a balloon filled with hydrogen slips out of your hand, it will float up into the air.

You might think stars would weigh very little. But stars are very big. They have so much hydrogen that even the whole Earth weighs much less than a star.

What weighs us down on Earth is its pull. The pull is called gravity. The bigger something is, the more gravity it has. You would weigh much more on a star, because it has much more gravity. It has a much bigger pull. A star's pull is so big that hydrogen cannot float away. A star is a heavy glowing ball of hydrogen, moving through space.

Where is the oldest republic?

The tiny country of San Marino, a few miles from

Rimini on the Adriatic coast and surrounded by Italy, set up its own government in the 10th Century. This makes San Marino the oldest surviving republic in the world.

According to legend it was founded in the 4th Century by Marinus, a stone cutter from Dalmatia (now part of Yugoslavia). He fled to a mountain retreat, Monte Titano, to escape persecution by the Roman Emperor Diocletian.

Marinus bequeathed this retreat to his followers to remain evermore as an island of liberty in a tyrannical world. The republic's capital, San Marino, is built around the three craggy tops of Monte Titano, which rises to a height of 2,425 feet almost in the centre of the country's 24 square miles.

Over the centuries the republic has been invaded several times but has always regained its independence. In 1861, the people of San Marino, considerate of others, wrote to Abraham Lincoln expressing their concern over the troubles in America. An appreciative Lincoln wrote back: "Although your dominion is small, your state is nevertheless one of the most honoured in history." Napoleon had offered this "model of a republic" additional territory in 1797, but San Marino declined to accept it.

The inhabitants are of Italian origin but they have one big problem. Over the centuries the families of the republic became so inter-related that the citizens found it impossible to provide a completely impartial system of law enforcement. Because of this they decided to "import' their judges and police forces from Italy. In this way the San Merino families have avoided feuds and family charges of favouritism.

What is a tornado?

Unusually violent weather is called a storm, and is always accompanied by high winds. Some of these winds have spiralling internal movements, and the revolving storms they produce are variously called tornadoes, whirlwinds, willy-willies, waterspouts and hurricanes.

Near the centre of a tornado is an area of calm known as the "eye" of the storm. This is simply a hollow vortex formed by the spiralling of the air, rather like the centre of a vortex of water going down a drain. Because of the suction in this low-pressure "eye", houses collapse and roofs are carried off, corks are drawn from bottles, and window panes fall outward.

Around the edge of the funnel-shaped cloud of the tornado, which looks like an enormous spinning top and almost touches the ground, the wind may blow at 200 miles an hour. The storm belt, only a few thousand feet wide, travels at 25 to 40 miles an hour, to the accompaniment of a deafening roar.

A waterspout is a tornado at sea, sucking in water and carrying it in an upward spiral with the wind to the overhanging cloud. A ship entering a waterspout soon finds her bridge and rigging covered with insects and birds. They are exhausted by their struggle in the side of the waterspout they have just passed through and are seizing the chance to rest in the "eye" before being caught up in the fury of the other side.

Tornadoes occur in the middle latitudes of the earth.

Are flamingoes always pink?

The colouring of the flamingo's plumage depends on its diet. It eats tiny crustaceans, filtered from the water in its huge curved bill, and it is the colour of these minute creatures that determines the flamingo's colour - anything from palest pink to rosy red. In captivity, if the flamingo's usual food is not available, the plumage turns quite white.

What is an agama?

Agamas are an important group of lizards found mainly in Africa and Asia, with only one, the starred lizard, living in Europe. They are beautifully coloured when in the sunlight during the day, but turn a dull brown at night, when they enter their underground homes. They are very active creatures, and their speed and excellent vision means that they are very successful hunters, eating insects. They have a reputation for being quarrelsome, and will defend their own territories to the death.

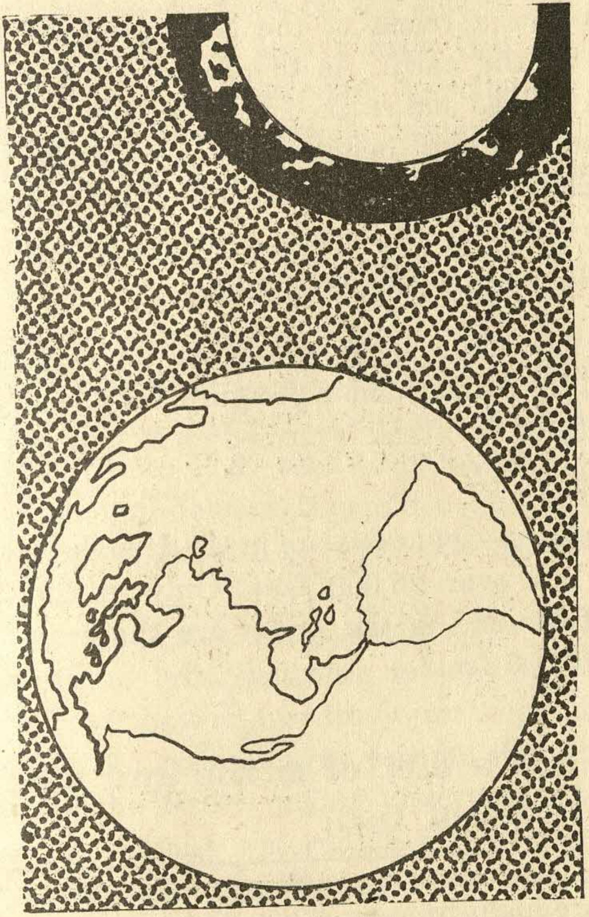
Why are surgeonfish so called?

Surgeonfish have a powerful weapon in the form of two blades or 'knives', embedded in the skin at the base of the caudal fin, used for attack as well as defence. These blades, which resemble surgeons' scalpels, give the fish their name.

Why is it cold in some places in the world and hot in others?

Where the Sun's rays shine directly on the Earth at right angles, they produce the maximum amount of heat. This happens at the equator, which is the hottest part of the Earth.

Where the Sun's rays fall at a slanting angle to the Earth they provide less heat. Therefore, The North Pole and the South Pole are the coldest places. As you travel further from the equator the weather becomes cooler. In Africa, for example, it is much



hotter than in northern Europe.

It is also colder at high altitudes, so a mountain top is colder than a valley.

What causes mountains?

The first mountains and valleys were the crust formed as a result of the cooling of the molten mass of the earth. As the planet contracted the crust twisted and cracked, forming new mountains. Mountains are still being formed by volcanic eruption. A crack in the earth's crust allows molten rock and ash to be forced out, forming a cone-shaped mountain growing as it continues to erupt.

Fault-mountains are formed when the earth's crust cracks, or faults, under pressure from inside, and one side of the break is pushed up against the other to form a cliff.

The highest mountains are in the Himalayas where some are over 25,000 feet. Only in the Rocky Mountains and in the Andes are there any other over 20,000 feet.

Who has a diet of snails and who has a diet of fish?

Owls are night hunters. They often nest near farms where they hunt rats, mice and beetles that scurry around the barns. They are usually regarded as friends by the farmer. In the woods, owls catch voles, moths, snails, lizards and swallow them whole.

The owl's eyes are designed to see well in the dark. Huge round pupils pick up every small glimmer of light. Unlike other birds of prey, the owl also relies heavily on its hearing when it is hunting. Its large ear slits, hidden by flaps on the side of the head, pick up squeaks and faint sounds that a human ear cannot hear. The owl hunts by following these sounds. It glides silently after its prey and only swoops when the animal has been pinpointed exactly.

The osprey builds its nest on the shore of a lake or in a tall tree near the water's edge. The nest is made from branches woven with seaweed, driftwood and dead plants. Although ospreys are found throughout the world, very few of them breed in Great Britain. They used to be hunted because of the supposed damage they did to the trout and salmon industries, but now they are protected by law.

The osprey is a fish eater. It flies low over the surface of the lake, watching for any movement underwater. It hovers over the water, then plunges in, feet first, to grab the prey with its sharp talons. Sometimes the bird is pulled underwater, but its feathers are almost waterproof, and it soon rises to the surface, clutching its prey. The osprey's claws are covered with spiny pads which help it to grip the wriggling, slippery fish. It twists its four outer toes to grasp the fish around the middle.

Where are stars born?

When you look through a big telescope, you can see giant clouds. The clouds are called nebulae. It is dark. It block off the light from stars behind it. Some nebulae glow. They catch the light of stars inside them. Inside these nebulae, scientists think stars like the Sun are being born.

Where was the greatest volcanic eruption?

The greatest volcanic eruption, in modern times, was on an island in the Sundra Strait between Sumatra and Java. On August 27, 1883, the volcano of Krakatoa suddenly erupted with a tremendous explosion that has been estimated to be the equivalent of 26 large atomic bombs. Rocks and ash were hurled up to 12 miles in the air and over half of the island was blown away. More than 160 villages were destroyed and 36,000 people were killed by 120-foot-high waves which were caused by the explosion.

The sound of the eruption was clearly heard four hours later nearly 3,000 miles away. Dust and ashes fell, days later, on Singapore and southern Java. Clouds of volcanic dust thrown high into the atmosphere travelled round the world and caused spectacular sunsets, even as far away as western Europe.

In the eruptions, which lasted two days, the highest part of the island became a huge crater which was filled by the sea. The remaining part was covered with layers of lava and ash which stayed hot for weeks.

No life was left on the island. But a small monkey was rescued from a floating piece of wood in the Sundra Strait. She was badly burned, but had survived one of the worst volcanic disasters ever recorded in history.

Why do ducks have webbed feet?

Ducks belong to the web-footed family of birds. All birds with webbed feet like the water, and during evolution the toes of these creatures have gradually been linked together by a skin, or web, which makes them well adapted to swimming. As the feet have a large surface area, they can paddle the bird along more swiftly in the water.

What makes fog?

Fog is a cloud which has come into contact with the ground. It is usually the result of condensation of water vapour in the air at the earth's surface. But on mountains a fog may merely be the result of clouds being formed in the free air and blown on to the slopes.

Fog is made up of water droplets, or sometimes ice crystals. It varies from a light haze or mist to the thick fog experienced in cities. The densest kind - also called smog - may be caused as much by smoke as by water.

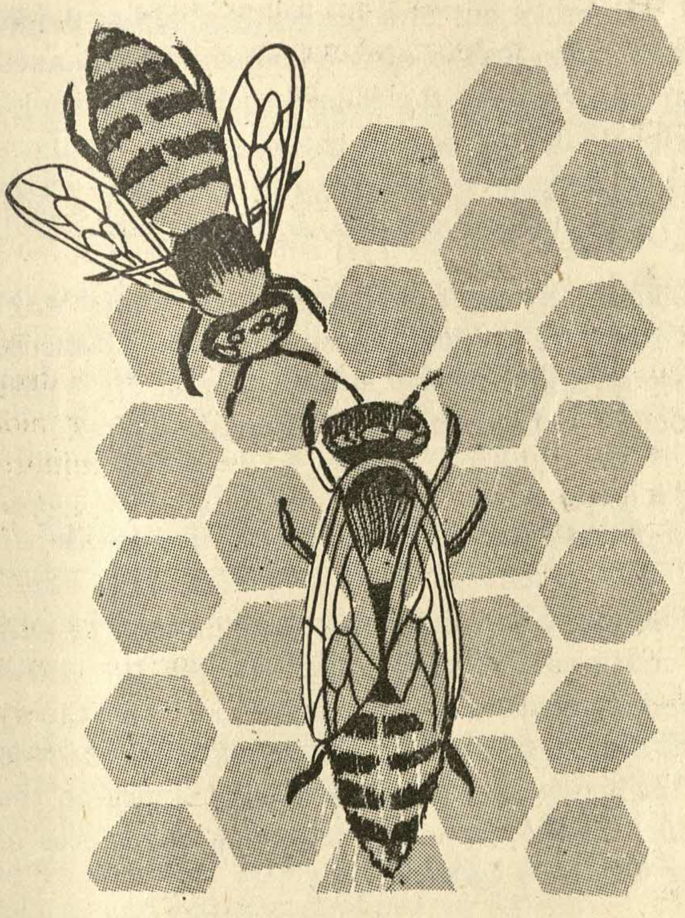
During the Second World War many attempts were made to dispose off fog artificially, so that runways for aircraft could be kept clear. A practical method developed in Britain was the burning of oil in jets arranged around an airfield. Th water drops evaporated and an area up to 100 feet or more above the runway was cleared in a few minutes. But it was an expensive remedy and was not adopted for general use.

Chemical methods, such as "seeding" the fog with dry ice, silver iodide or calcium chloride spray to make the water droplets fall as rain, have been investigated since 1955. But no really satisfactory method has so far been discovered.

Why do bees produce honey?

There are three classes of bee in the bee world-queens, workers and drones.

Worker bees make the honey, using nectar collected from flowers and special saliva produced by the bee. The honey is used to feed the developing larvae in the first stages of life and the adult bees during



the winter months. Man has learnt to take the honey to sweeten and flavour his food. Honey is an energy-giving food, rich in vitamins.

Which disaster began in Pudding Lane?

In the early hours of the morning, during September

1666, fire broke out in a bakery in Pudding Lane, east of London Bridge, after a long drought. Fanned by an easterly gale, the flames soon spread across the city: 13,000 houses, 84 churches, and countless other buildings were destroyed in the blaze, which lasted four days, and was seen as far away as Oxford.

Incredibly, only eight died, and in two crucial ways the Great Fire actually proved beneficial, cleansing the worst plague areas, and allowing at least part of London to be rebuilt by Christopher Wren.

Why did the continents drift apart?

One of the most convincing explanations of why the continents drifted apart is that the earth expanded considerably after its creation. This theory can be illustrated by imagining the earth as a balloon and the continents as pieces of paper stuck on the outside. As the balloon is blown up the pieces of paper will grow farther apart.

Other theories suggest that the continent only appeared to drift apart because masses of land were drowned under volcanic waters. But it has been demonstrated that land masses are, in fact, made to drift, by the heat generated from the earth's interior and from earthquakes.

Probably a combination of various theories may be necessary to provide a complete explanation.

What was Atlantis?

Ancient legends describe a powerful country called Atlantis. High mountains surrounded a fertile plain where the people grew rich crops. They built cities with fine palaces and temples and dug canals for the water supply. But in time, the people of Atlantis grew greedy and spiteful. Suddenly a terrible disaster took place. The whole country disappeared forever beneath the sea. Many people have tried to find Atlantis. Some said it lay buried below the Atlantic Ocean or the North Sea. Today, archaeologists and historians believe that the lost world lies under the Aegean Sea, near the island of Thera. They have found remains of buildings and a palace containing ornaments and household objects.

It seems that the island of Thera, or Atlantis, was destroyed by volcanic eruptions, followed by earthquakes. The land was covered in ash and pumice. Later, great tidal waves swept over the island, and Atlantis disappeared forever.

How a star is born?

Astronomers have never seen a star form, because it takes a very long time. The Sun probably formed in a nebula of gas and dust in space.
How do stars form? Dust and gas in the nebula

come together. After a long time, the dust and gas is packed together. Bits of the dust and gas bump into each other and get hot, the way your hands do if you rub them hard. When the dust and gas are hot, the star begins to glow feebly. After many millions of years, the star gets hot enough for nuclear reaction to begin. These reactions then keep the star glowing for the rest of its life.

In a big nebula whole groups of stars may be born at the same time. Astronomers believe that the star group called the Pleiades formed in this way.

What is the Heligoland Bight?

The Heligoland Bight is an arm of the North Sea extending south and east of the red sandstone island of Heligoland. Heligoland is a small remote island of the German North Frisian group lying in the North Sea between the coast of Schleswig-Holstein and the estuaries of the Jade, Weser and Elbe. It is 5,249 feet long and 1,640 feet wide at its broadest point.

In 1807 Heligoland was a Danish possession but it was seized by the English in 1814 and given to Germany in 1890. Before 1914 Germany developed it as a great naval base with an extensive harbour in the south-east. There was a network of underground fortifications and coastal batteries and it was known as the "Gibraltar of the North Sea". Th Heligoland Bight became famous as the scene of a naval battle between the British and the Germans on August 28th, 1914.

Heligoland became a stronghold again under the Nazis and the capital town of Heligoland was destroyed by Allied bombers. In 1947 the whole character of the island was changed by the destruction of the fortifications.

Where is the Emerald Isle?

This is a romantic name for Ireland, the second largest of the British Isles, which is farther into the Atlantic Ocean and the warm Gulf Stream current than its bigger neighbour to the east. The moist prevailing westerly winds bring between 30 and 50 inches of rainfall each year and maintain a temperature ranging between 0° and 21° Centigrade. All this gives the countryside a rare greenness - hence its popular description as the Emerald Isle.

When was the San Francisco Earthquake?

San Francisco lies along the notorious San Andreas Fault in California, a geological split in the Earth's surface. At 5.15am on **18th April 1906**, the first of several massive tremors split streets and collapsed buildings throughout the city.

A giant tidal wave hit the waterfront, and fractured electricity cables and gas mains, starting fires which burned for three days. 25,000 buildings were lost, and almost £150,000,000 of damage caused, although miraculously less than 500 people died.

Why do avalanches occur?

An avalanche occurs when a mass of snow which has built up on a mountain side begins to slip and finally to fall. There can also be avalanches of earth, stones, rock and ice, but usually the word is used to describe a rapid fall of snow.

Snow builds up to great thickness on steep slopes, especially if the surface is not smooth. Even a very small disturbance may set it in motion. The vibration of a passing vehicle, the movement of a man or animal, the fall of a tree branch or even a sound can cause thousands of tons of snow to crash down a mountainside.

The speed of an avalanche varies enormously, but some have been estimated to move at about 200 miles an hour. A big avalanche hurtles down the side of the mountain with a thunderous roar, crushing or sweeping away anything in its path.

The swiftly moving mass of snow pushes the air in front of it with such violence that it fans out sideways as well as driving directly ahead. This wind sometimes reaches a force almost equal to that of a tornado. This great wind is often a more powerful force of destruction than the avalanche itself.

How do lions hunt?

Lions usually live together in a large family group called a pride. A pride may contain about fifteen lions, lionesses and cubs. The lionesses and cubs hunt, sleep and play together, while the lions look on, ready to protect them all fiercely.

When the pride goes hunting together, the work is shared. The pride stalks the prey, hidden by the undergrowth. One lioness leaves the pride and moves around into the wild. Her smell is carried to the grazing herd, who raise their heads in alarm. As the lioness rises, roaring, from the grass, they run quickly from her, driven forward into a waiting ambush of the other lions.

The lioness knows that towards dusk many animals go to the water hole or river to drink. Her sharp ears and eyes pick up the movement of a herd.

When she hunts alone, she approaches quietly, taking care that the wind is blowing towards her and carrying her scent away from the unsuspecting animals. She crawls silently forwards on her belly, crouching low in the grass or bushes. Suddenly she rushes. Her body arches and she springs onto the back of her prey, hauling it to the ground. In a flash, the lioness sinks her fangs into the animal's throat.

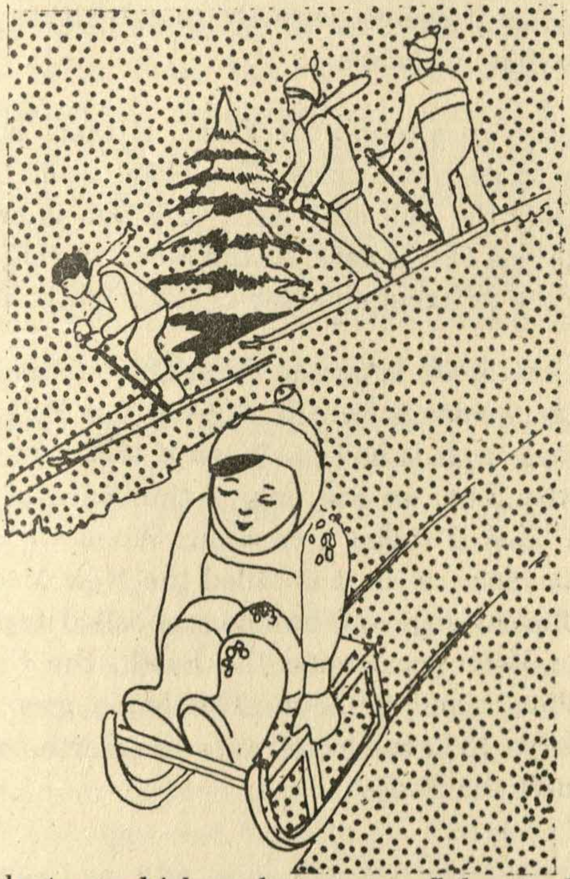
She drags away the carcass to a quiet spot where her family can eat its fill, the lion eating the most. A lioness gives birth to cubs every two years or so. There may be two or three cubs in the litter. While young, the cubs feed from her milk. Sometimes a second lioness helps to rear and train the litter. At first, a cub's legs are weak. He rolls and staggers from side to side as he follows after his mother. The cubs tease the adult lions, nipping them with tiny teeth, or leaping on them with a squeaky growl. The rest of the time they sleep or gambol together.

The cubs are soon old enough to follow their mother on hunts. They copy her actions and when they are two years old, they will be able to hunt for themselves.

Why does it snow in winter?

As the Earth spins round, it is also tilted on its axis. When the tilt is away from the Sun, the Earth receives less of the Sun's heat. This is the winter season when the weather is cold.

When it is very cold the drops of water which make up clouds freeze and form tiny crystals. These crystals form clusters which make up snowflakes and they fall to the ground without melting. They pile up and form quite a solid mass. If you catch a snowflake and put it under a microscope, you will see that it forms a very pretty pattern. The wonderful thing is that each snowflake has a different pattern.



How does the Moon moves?

The Moon does not always look the same shape. Sometimes it seems perfectly round. Other times it looks like a banana.

The Moon goes round the Earth. It takes about a month to go round once. The Moon is lit by the Sun. Only the half of it facing the Sun is brightly lit. The rest of it is dark. As the Moon travels round us, we see different amounts of the brightly lit part.

When the Moon is on the other side of the sky to the Sun, we see it fully lit. We call this Full Moon. Sideways on, it is half lit. When it is nearly in line with the Sun, we see only a thin slice of lit-up Moon. This is called a crescent. When we cannot see the Moon at all it is called the New Moon. All the different shapes of the Moon are called its phases. As the Moon goes round the Earth, the Earth is travelling round the Sun. The Moon goes round the Earth 13 times in the year the Earth takes to go round the Sun.

What is the Date Line?

The Date Line (usually called the International Date Line), is a north-south line through the Pacific Ocean where, according to international agreement, the date changes. East of the line it is one day earlier than it is to the west.

The line is necessary because the earth is divided, longitudinally, into 24 one-hour time zones (15 degrees longitude each) which make one full day on the earth. Since the earth rotates eastwards, the time on the clock progresses westward round the world. Thus, 12 o'clock noon arrives in London (0 degree longitude) five hours before it does in Washington, D.C. (75 degrees west of London) and eight hours before it does at San Francisco (120 degrees west of London). When it is noon in London it is midnight 180 degrees to the west.

On either side of the 180th meridian the time is the same. But you would lose a day if you crossed it from the east and gain one if you travelled from the west.

The Date Line has some variations from the 180th meridian to allow for land areas or islands. The line bulges eastward through Bering Strait to take in eastern Siberia and then westward to include the Aleutian Islands with Alaska. South of the equator it bulges east again to allow various island groups to have the same day as New Zealand.

Where does gold come from?

The main gold-producing regions of the world are in the Republic of South Africa, Ghana, Southern

Rhodesia, the Congo, the Soviet Union, Canada, the United States, Australia, Columbia and the Philippines.

Many wars of ancient times were fought principally to secure gold as loot. Alexander the Great brought back vast quantities of gold from his Persian expeditions. During the Middle Ages alchemists sought the Philosopher's Stone, which would turn base metals into gold.

Exploration was stimulated by the search for the metal. The promise of it from the Indies helped Columbus to get support for his expedition. Spanish gold from Mexico and Peru greatly increased the stock held in Europe. Rich deposits were discovered in Colombia and Brazil in the 18th and 19th Centuries, and these were the world's chief sources of supply for 200 years.

In 1848 a gold strike was made in California and hundreds of thousands of men poured into the Golden West. Many died, but some survivors became very rich, for California was soon yielding £10 million worth of gold every year. In 1851 new veins were found in Australia. The third great gold rush of the century occurred in 1896, when the Klondike goldfield was discovered in the far north-west of Canada.

The world's richest known source was discovered in 1884 in South Africa. near what is now

Johannesburg. This is the great gold-bearing reef of the Witwatersrand which has produced more than £4,000 million worth of gold. Its annual output is more than half the world's total supply.

Why do earthquakes only occur in certain places?

Earthquakes occur mainly in the regions of the earth where mountains are being formed, and where the earth's crust is under strain.

Some mountains are formed of great thicknesses of folded sedimentary rock laid down beneath the sea. Heat currents deep within the earth are thought to suck down sections of the undersea crust and so produce great trenches thousands of feet deep. When the heat currents die away the material forming the bottom of the trench begins to rise because it is lighter in weight. Eventually it is thrust up as a mountain range.

This is never a smooth process but is accompanied by great friction and heat, as well as by rending and shearing and tearing. The tearing and shearing of deep underground rocks connected with mountain formation cause earthquakes. Even small underground movements may produce violent surface shocks. The great Tokyo earthquakes of 1923 which is believed to have killed 25 million people was caused by the twisting of a section of the earth's crust in Sagami Bay.

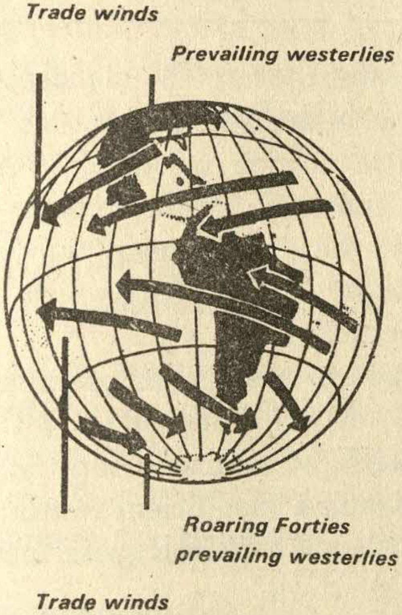
As might be expected, ocean trenches are the seat of a great many earthquakes, for there the earth's crust is in an unstable state. Indeed all the deep earthquakes - those taking place more than 160 miles below the surface - originate around the Pacific trenches. About 90 per cent of the intermediate earthquakes (30 to 160 miles deep) also originate there, as do 40 per cent of the shallow earthquakes (less then 30 miles deep).

Some shallow and intermediate earthquakes are caused by volcanoes or by a slight shifting of layers of rock at a weak place or "fault" on the earth's surface. One of the most famous and widely publicized of these is the San Andreas fault on which San Francisco is built.

Where are the Roaring Forties?

The Roaring Forties are westerly winds found between latitudes 40° and 60° South. They are prevailing winds resulting from the large, planetary circulation of the atmosphere.

The prevailing westerlies occur in both hemispheres in the middle latitudes (30° - 60°), but in the Northern Hemisphere the great continental land masses of



North America and Asia create a disturbance to the regular wind pattern and it is only in the Southern Hemisphere, with its small land masses, that these westerlies sweep unimpeded across the Southern oceans.

Intense, blustering, cold and often stormy, these winds were given their name by sailors who, in the days of sail, made the outward voyage to Australia by way of the Cape of Good Hope at Africa's southern tip and the return passage via Cape Horn, the southernmost tip of South America. In this way, sailing vessels would have the advantage of a following wind for both passages.

Why did the Titanic sink?

The *Titanic* was the largest and most luxurious liner of her time when she set out on her maiden, transatlantic voyage in April 1912 with 2,200 passengers and crew. Despite reports of icebergs in the vicinity, the *Titanic* maintained her speed of 22 knots and struck an iceberg which tore a 300-foot gash in her hull.

Described by her makers as unsinkable, the ship was capable of remaining afloat with two of her sixteen watertight compartments flooded, but six were in fact holed. Insufficient warning to abandon ship and inadequate lifeboat space meant that only 705 people survived.

How are vultures useful?

Vultures have ugly bald heads, often with a twisted and brightly coloured growth called a wattle, on their beaks. Some have blood red or bright yellow eyes and scraggy necks circled by ruffs of shaggy feathers.

Vultures are carrion eaters. The Condor, a large kind of vulture with a wingspan of three metres, feeds off dead cattle, sheep and rotting carcasses killed by other animals. They also feed off rubbish heaps.

Vultures have a reputation for being evil, unpleasant birds. Often they circle overhead or sit calmly waiting for their prey to die, before flocking in to rip its bones bare. In fact, vultures are useful because by clearing up rotting bodies, they help stop the spread of disease.

What is Jupiter made of?

Most of Jupiter is made of gas. Astronomers are not sure if Jupiter has a solid core. Some think that Jupiter's gas is like a thick atmosphere, over a rocky centre. They think that without its gas, Jupiter might look like the Earth.

But most astronomers think that Jupiter is made of gas all the way through. They think that if Jupiter had been bigger, it might have become a small star.

What is a National Park?

A National Park is an area where natural scenery and wildlife is protected by law to preserve them for future generations. It is only recently that man has realized that he must make a positive effort if many species of wildlife and areas of great beauty are not to disappear for ever.

There are many kinds of areas of conservation and their central priorities may differ slightly. In the

U.S.A., a national park such as Yellowstone safeguards natural features and wildlife in a way that will contribute to public enjoyment. In Africa generally, as in the Amboseli Game Reserve, the chief purpose is the preservation of the remnants of the great herds of animals which once roamed the country.

National Parks depend on tourists for revenue but the animals must remain unmolested. To solve the problem many parks restrict visitors' movements by setting aside areas for hotels, restaurants and parking places and providing a limited number of roads through the park. National Parks may be small or large, privately or government owned.

What are carnivorous plants?

These are plants which trap insects and small animals. They are found all over the world, and use various methods to trap their victims. The Pitcher plant has large, hollow leaves resembling a pitcher, and each is partly filled with sweet sticky liquid. The insects are attracted to this liquid and once inside they drown. Butterworts have broad, sticky leaves on which insects get caught, while the Venus's fly-trap has leaves which snap shut when an insect crawls on the surface. In each case, the plant absorbs the liquid nourishment from the bodies of the decomposing insects.

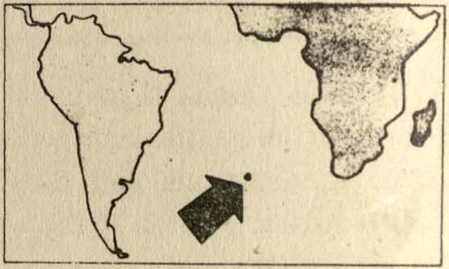
Where is Tristan da Cunha?

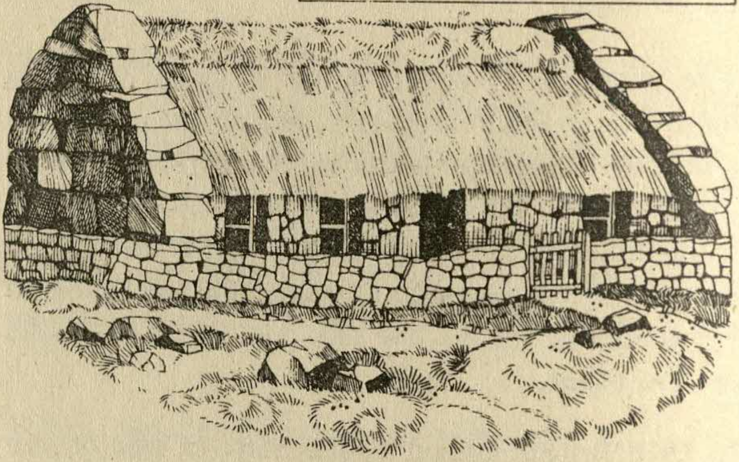
Tristan da Cunha is one of five small and remote islands in the South Atlantic midway between Buenos Aires in Argentina and the Cape of Good Hope, South Africa. Tristan is the only one of the five to be inhabited.

The island is 37 square miles in extent and was named after the Portuguese admiral who discovered it in 1506. Tristan da Cunha was created in prehistoric times when a volcanic eruption raised it 18,000 feet from the seabed. Cultivation is possible only on one part of the rocky outcrop, on a small plateau squeezed between the sea on one side and 2,000 foot cliffs on the other.

In 1816 Britain landed a small force of men on the island and took possession. The garrison stayed for a year. When it departed, one of its members, Corporal William Glass, was allowed to remain on Tristan with his family. With the arrival of shipwrecked sailors and of five women from St Helena, the population grew to 260 by 1961.

For 150 years the islanders' way of life changed little. But in 1961 the volcano erupted and forced their departure to England. This evacuation seemed to be the end of life on Tristan but, weary of contact with modern civilization and longing for their island ways, the people began to return two years later.





The Tristan da Cunha Development Company now provides the island's sole industry. By 1967 Tristan had a small harbour for the first time in its history. After that a road, a new hospital and a sewage system were built, and electricity was introduced. The island now has something approaching the best of both worlds, isolation and "away from it all" atmosphere but some modern amenities, too.

How do owls keep so still?

The owl, a common visitor to church belfries and old ruined towers, is a night bird which sits very still for long periods of time. It has very sharp hearing, but because its eyes are at the front of its head its vision is not very well developed. However, as it can turn its head almost right round it can keep a constant lookout without altering its position. Because it is able to do this, and because of the long, drawn out piercing shriek it makes, this bird of prey is not very popular.

Which beasts are magical?

The griffin is a legendary beast that has the body of a lion, the wings and head of an eagle and the ears of a horse. It has a red front, a blue neck, white wings and black feathers on its back. It is as strong as two hundred eagles and can carry off two oxen in one mighty claw.

Griffins were said to live in the mountains of Scythia, and ancient country near Persia. They spun great nests of gold and fiercely guarded the entrances to hoards of hidden treasure. A group of one-eyed people lived nearby, who liked to plait gold thread into their hair. Sometimes they tried to creep up unseen to steal gold from the griffins' nests. If the griffins caught the thieves, they tore them to pieces before they could escape.

An ancient Egyptian legend tells of a wonderful bird, like a golden eagle, called a Phoenix. At the end of its life, it burned itself to death in a huge fire. Then the Phoenix rose from its own ashes to begin a new life.

When the huge, fossilized bones of dinosaurs were first unearthed, many people believed that these were the remains of dragons. However, dragons are imaginary creatures. They were first mentioned in stories told long ago when they were described as magical lizards. In later tales they became fierce monsters with huge wings, sharp claws, scaly bodies and nostrils that belched fire and smoke.

Where is the Kremlin?

The Kremlin was the palace of the Russian Tsars in Moscow until Peter the Great (1672-1725) moved the whole imperial court to the newly-founded city of St Petersburg (now Leningrad) early in the 18th Century.

In 1922 Moscow was chosen as the capital of the Union of Soviet Socialist Republics. Once again the Kremlin became the headquarters of government.

Encircled by great battlements erected in the 15th Century, the citadel covers an area of 65 acres and is almost a city itself. Around the walls are 19 towers and five gates, the finest of them being Spasskaya

(Soviour's) Tower and Gate which houses the Kremlin chimes. Men used to doff their hats as they passed by this gate in Red Square.

Within the walls are churches, four cathedrals and many palaces. In 1955 the Kremlin was opened to the public and the palaces now exhibit the riches of Tsarist days.

Outside the walls is Red Square, 900 yards long by 175 yards wide, where the great military parades are held annually to commemorate the revolution of 1917. The embalmed body of Lenin (1870-1924), leader of the revolution, lies in its mausoleum in front of the Kremlin's wall.

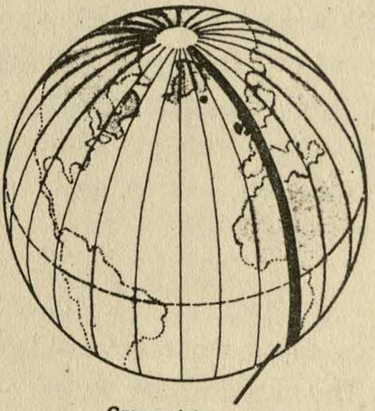
The defensive fortresses at the centre of many medieval Russian cities were also called Kremlin, which is where the word comes from.

Where is nought longitude?

Nought degrees longitude passes through Greenwich on the River Thames in London, England. 0° longitude is known as the "prime meridian". You can see at Greenwich the prime meridian mark from which all countries have reckoned longitude since 1884.

Longitude and latitude are fixed lines crossing the globe by which the location of any place on the earth's surface can be determined and described.

Lines of longitude go from north to south. All start at the North Pole and end at the South Pole. Longitude is measured both 180° east and 180° west of the meridian, the two together making the full 360° of the earth's circumference.



World time is also measured from Greenwich. Greenwich Mean Time is zero hour and, depending on whether you are west or east of the prime meridian, you are either so many hours behind or ahead of the time of Greenwich.

The Royal Observatory at Greenwich was founded in 1675 and was one of Sir Christopher Wren's great designs. In 1960 the building was opened as an astronomical museum.

Where is the legendary land of the Long White Cloud?

The Land of the Long White Cloud is a translation of the Polynesian name for New Zealand. In the 12th Century, bands of Polynesian adventurers voyaged thousands of miles from their Pacific islands and made landfall in the country they named Ao-tea-roa.

The descendants of those adventurers are the friendly and highly intelligent people we know as the Maoris, the original settlers of New Zealand. The land and its people were discovered and named by the Dutch navigator Abel Janszoon Tasman in 1642, although he never landed.

It was not until 1769 that a European set foot in the country. Captain James Cook, the English explorer, landed in New Zealand and then sailed on to Australia. In the next eight years he came back three times.

The first settlers were sealers, whalers and traders. In 1814 a British missionary, the Rev. Samuel Marsden, began work among the Maoris. Within six years he had been joined by a number of British emigrants, and New Zealand was made a British colony. It became a dominion in 1907.

New Zealand consists of two main islands. From the top of North Island to the bottom of South Island the country is scarcely 1,000 miles long. Nowhere is it wider than 280 miles, and usually it is much narrower. But within this compass it is a land of strange and beautiful contrasts.

New Zealand's 3,000,000 inhabitants live a life where poverty is unknown and serious crime is rare. The climate is temperate and the scenery spectacular.

It is a curious fact New Zealand has no native land animals. The ancestors of the pigs, goats, rabbits, opossums, weasels and ferrets were imported. Some of the animals - rabbits for example - have since become pests. In compensation New Zealand has a huge variety of fish and birds.

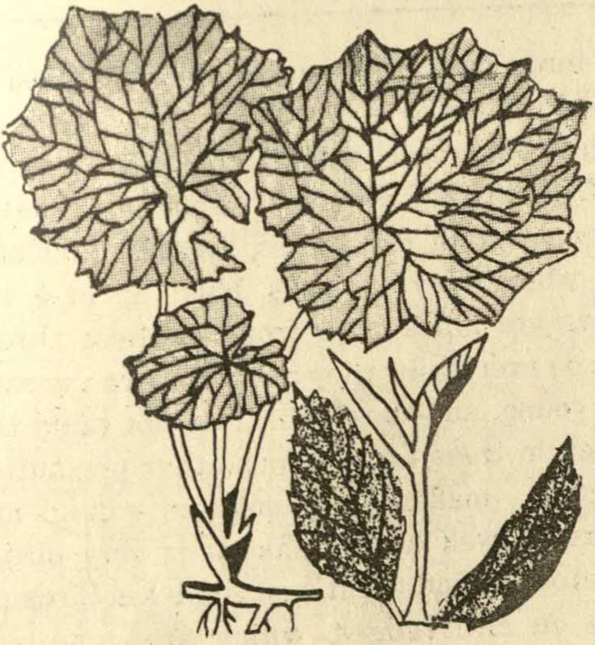
In spite of its small population, the country has produced many outstanding writers, artists, musicians and scientists and has given support and encouragement to the revival and development of Maori arts and crafts.

Why do tree trunks have circles in them?

When a tree is cut down, you can see a number of dark circles in the wood, which get smaller towards the centre. The older the tree, the more circles there are. A tree grows much more in the spring and summer than in autumn and winter. Within the trunk is a ring of cells. As the tree grows, the cells increase. The woody cells that are produced in spring and summer appear as light-coloured rings. When the growth slows down in colder months, the wood hardens and becomes darker. So one year's growth is marked by this dark ring. By counting the number of dark rings it is possible to work out how old the tree is.

Why do leaves have veins?

The water and minerals that a tree or plant needs to keep it healthy are absorbed from the soil through



the roots. These nutrients, which are the plant's food, then have to be taken to every part of the plant.

The liquid which carries nutrients through plants and trees is called sap. The circulation of the sap is similar to the circulation of blood in the human body. The sap is carried by capillary vessels, or veins. When the veins arrive at the edges of leaves, they branch out and get narrower, so that every part of the leaf is nourished. These veins make a very attractive pattern on the surface of the leaves.

Why do birds build their nests high in trees?

Not all birds build their nests high in trees, but many do, and there is a very good reason for it. When the young birds hatch from their eggs, they cannot fly, and they are very vulnerable. There is great danger from cats, foxes, weasels and other animals which prey on birds. High up in a tree, the young are much safer from all these threats. All birds do everything they can to ensure the safety of their young, and those which do not build their nests high in trees take various other precautions. Many ducks - mallards, for instance - build nests which are so well hidden that it is very difficult for predators to find them, and some sea birds nest high up on cliff ledges, which are completely inaccessible to most animal enemies.

Where is Easter Island?

Easter Island, one of the most mysterious islands in the world, is in the South Pacific, 2,000 miles west of Caldera in Chile and 1,000 miles east of Pitcairn, its nearest inhabited neighbour. It was annexed by Chile in 1888. The island which is volcanic in origin, was discovered by the Dutch admiral Jacob Roggeveen on Easter Sunday, 1722. It is 11 miles long and 15 miles wide.

Easter Island is noted for its mysterious statues of remote and unknown origin. These statues, consisting of giant heads facing inland, fringe the island's coastline. They stand on huge ramparts or platforms which slope landwards, in some cases to a width of 250 feet. At the end of this sloping rampart there is a paved area.

There are some 260 of these platforms on the island and each one was designed to support between one and 15 of the strange giant heads, carved from compressed volcanic earth. The heads have upturned faces tilted towards the sky, and long ears. They vary in height from 12 to 20 feet. At one time they were topped by huge hats or crowns between six and eight feet in diameter. These hats are made from a red volcanic material different from the material used for the heads themselves.

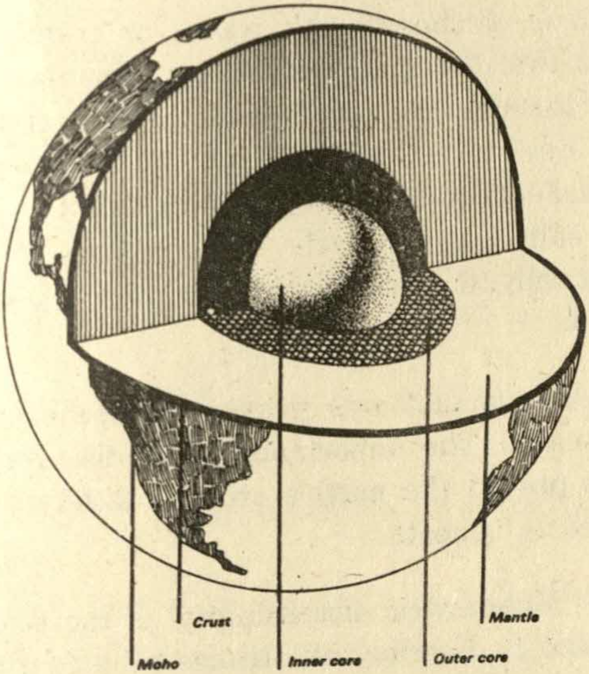
The island is full of ancient curiosities including long, narrow boat-shaped houses flanked by stone chicken huts. The inhabitants are descendants of Polynesian people who migrated across the Pacific.

There is a legend of a war between the "long-eared" people and their "short-eared" attackers. The long-eared defenders of the island were said to have been burned in a vast earth oven, but the latest scientific evidence suggests that the "earth oven" was in fact a vast defensive ditch. Ashes in this ditch date from the 17th Century, only a short time before the island's discovery.

But the real truth about Easter Island and its mysterious statues will probably never be known until someone finds out how to read the curious sign language inscribed round the platforms. These signs, which are geometrical in form, are really symbols such as birds, plants and fishes. They may be like the "memory aids" of the ancient Aztecs, but experts believe they are an elementary form of writing.

Where is the "Moho" - or Mohorovicic discontinuity?

The Mohorovicic discontinuity is to be found between the earth's crust and the earth's mantle. Mohorovicic was a famous Croatian scientist, a seismologist. He specialized in the composition of the earth, and particularly in earthquakes and in faults in the structure of the earth, which are the cause of earthquakes.



Mohorovicic made a most important discovery. Scientists knew that the earth is made up of a series of layers, rather like an onion. There are many of these layers, all of different materials and all in a different state of development. The main layers are called the crust, the mantle, the liquid core and the solid core.

The great pressures inside the earth force the weaker areas of the rocky layers out of alignment and this pushing, twisting movement is experienced as an earthquake on the surface. These great forces set up a series of waves throughout the various layers of the earth, known as seismic waves.

Mohorovicic discovered a curious fact about the behaviour of these earth waves or tremors. He noticed that the shock waves travel comparatively slowly through the actual crust of the earth. But when they reach the lowest level of the crust - the layer called basaltic rock which rests on the next layer called the mantle - the waves increase dramatically in speed. Sometimes they also change direction.

This curious fact was proved by Mohorovicic's experiments. The importance of his discovery was that it proved the earth's crust is different from the mantle beneath.

So the "Mohorovicic discontinuity" is the scientific term used to describe this strange behaviour of the earth's shock waves.

Usually this level of the earth's composition is called the Moho, since even scientists found Mohorovicic's name difficult to pronounce! By plotting these earth waves on sensitive shock recording machines known as seismographs we have found that most of the outer crust of the earth is between 20 and 25 miles thick in continental areas, but only three miles thick under some oceans.

Why do the leaves of some trees change colour in autumn?

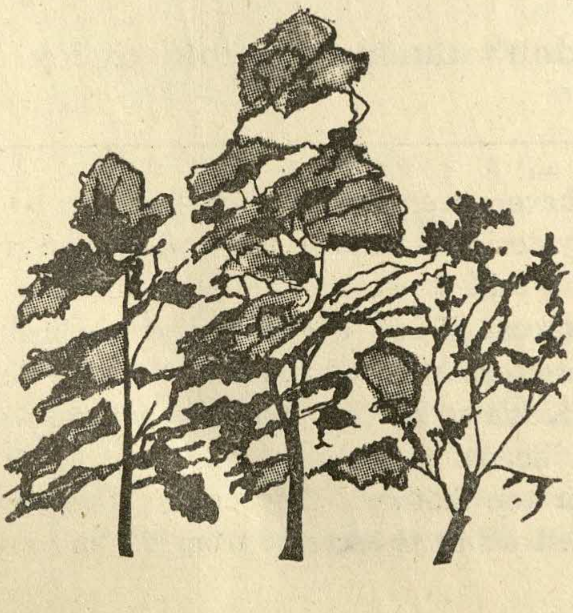
Green leaves contain a pigment called chlorophyll that gives them a green colour. During the autumn, when there is less sunlight and the temperature is lower, the chlorophyll changes and disappears. Then yellow and orange pigments, known as carotenes, become visible. So the leaves gradually change from green through a range of orange/red shades to yellow. Then they dry up and drop from the tree. The changing colours of the trees in the autumn make the countryside very beautiful.

Why don't ducks feel cold in icy water?

Ducks have a wonderful coat of feathers, which is specially designed to keep them warm and snug in even the coldest weather. First of all, they have an undercoat of soft downy feathers, which grow very close together, and trap a 'cushion' of air next to the duck's body. This stops the natural warmth of their bodies escaping into the cold outside. As for their top feathers, they protect these with a special oil which is secreted from a gland in their bodies. When you watch a duck preening its feathers, it is spreading this oil all over them, making its top coat of feathers completely waterproof. Neither water nor cold can penetrate the feathers from the outside, and the body warmth cannot escape through the down, and so the lucky duck stays warm and dry. Would you like a coat of feathers like that?

Where can you visit a volcano?

Mount Etna, on the island of Sicily in the Mediterranean, is an active volcano that erupts every few years. When it erupts, the lava flows down the mountainside. The small villages on the slopes are destroyed. Families lose their homes and possessions.



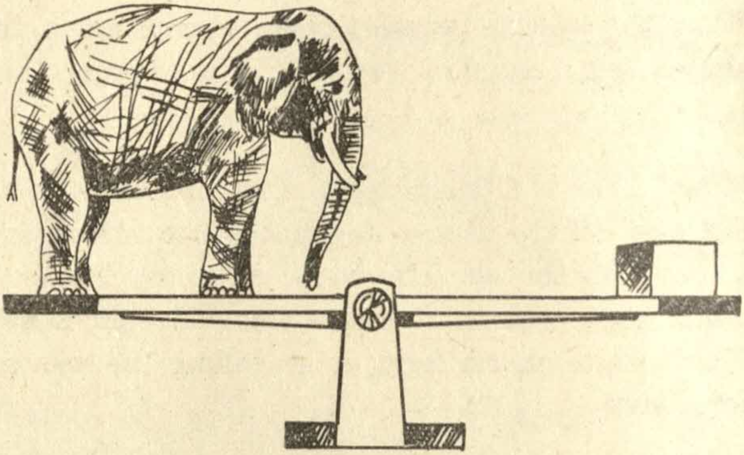
When the volcano becomes peaceful once again, the slopes are crowded with curious visitors and reporters.

Mount Etna is a magnificent sight. It towers above the rest of the island and pours hot steam and smoke into the air. The warm air rising from the crater soon cools as it meets the colder air above. Thick white clouds form, often hiding the summit from view.

There is a road that winds and twists up Mount Etna as the slope grows steeper. When the volcano is quiet, visitors leave their cars and crowd into cable cars that swing them slowly upwards through the clouds around the summit. At the top, jeeps carry the tourists several miles across the dark, grey wastes of lava and ash towards the crater. No birds fly here; no plants grow, except for a few struggling lichens and patches of green fungus. It is dead and still. The visitors see the choking smoke and fumes. They hear the rumble and hiss of escaping steam. They gaze into the vent that leads into the fiery depths of the Earth.

What is the world's heaviest metal?

The heaviest metal in the world is iridium. It was discovered in 1804 by Smithson Tennant of the United Kingdom. Iridium, which is a silvery-white



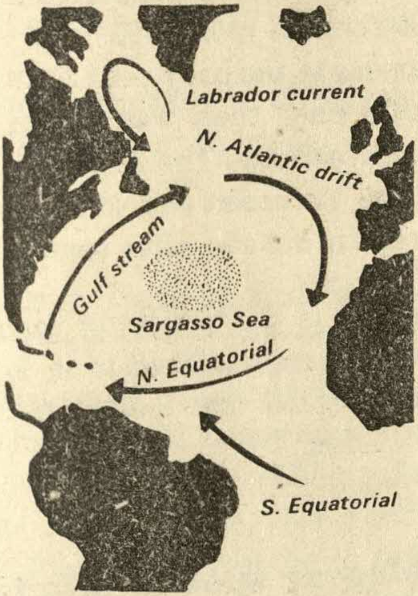
metal of the platinum group, weighs 1,414 pounds a cubic foot or roughly two-thirds of a ton. Lithium, the lightest metal, weighs 33 pounds per cubic foot.

If you could stand an elephant weighing nearly six tons at one end of a seesaw, you would need only a two-foot cube of iridium at the other end to lift the animal. Such a cube would cost nearly £15,000,000.

Where is the Sargasso Sea?

The Sargasso Sea is in the Atlantic Ocean south of the Bermudas and several hundred miles east of the American mainland. It is famous for its seaweed and as a spawning ground for eels.

When these eels are eight or more years old and spawning time is due, they leave the pond or stream where they have been living and make their way, over land if necessary, to the sea.



When they reach the area known as the Sargasso, the females lay their millions of eggs at a depth of 1,500 feet and the males fertilize them. The baby eels hatch out after a few days and float to the surface. Vast masses of seaweed lie on the surface of the Sargasso.

Carried along by winds and ocean currents from the Gulf of Mexico and Caribbean Sea, this floating seaweed is concentrated into an area many thousand of square miles in extent. There it gives refuge to myriads of sea creatures, such as fish, sea-worms, molluscs, crabs and jellyfish. Sea birds find it useful as a resting place.

This floating "island" may have given rise to the famous legend in ancient times of the lost land of Atlantis. Christopher Columbus recorded taking two weeks to sail through it in 1492.

But what happens to the baby eels? Drifting at first, they eventually make their way to the ponds and streams of their parents. The American eels go to America and the European eels to Europe. The old eels do not return but die after spawning.

The Sargasso Sea is the subject of many legends. Ships are said to have vanished in it, but there is no truth in the legend that associates it with the lost land of Atlantis.

Where is Magyar spoken officially?

The Magyar language is the official language of Hungary (or, in the Magyar language, the country of Magyarorszaq). In 1967 the population was 10,197,000 with another two million Magyar-speaking people living outside Hungary - mainly in Czechoslovakia, Rumania and Yugoslavia. Nearly half a million Magyars live in the United States of America.

Magyar belongs to the Arabic language family. Apart from Finland, where the language is closely related to Hungarian, the only part of the world you are likely to hear anything similar is in western Siberia.

Because several suffixes, or smaller words, are often added, the Magyars can produce words of considerable length. For instance, "the very biggest" would be "legeslegnagyobb" in Magyar.

The first written example of Magyar dates from about 1200, when a short funeral oration was recorded.

How does a lion spend its day?

The lion wakes lazily. Throughout the hot day he has rested in the shade, saving his energy for hunting. Now it is evening, and he is hungry. As he stretches and arches his backbone, five hundred powerful muscles tighten. Now that he is fully grown, his body is nearly three metres long from his head to the tip of his tail. It is sleek and streamlined.

When he yawns, he bares four pointed fangs and rows of sharp, strong teeth to cut, rip and tear raw meat. His tongue is long and rough like sandpaper. It can strip a bone clean.

The lion gets up on four broad and shaggy paws. Fleshy pads on his heels and under his toes help him to jump and to land with a bouncy spring. When he attacks, his sharp claws dart out.

The lion must eat a lot of meat to keep up his strength so he can protect the pride. Each fortnight he will get through a whole animal. There is little shortage of food, for the grazing herds of gazelle and antelope breed and grow quickly. Without some form of control, their numbers would grow and grow, and soon strip the grassland bare, causing widespread famine. In their own way, the lions help to preserve the balance of wild life in the African bush.

The lioness is the chief hunter. The lion's main duty is to protect the pride from attack. A lioness hunting alone will attack zebra, wildebeeste or gazelle. All these animals are strong runners, and the lioness would tire first in a chase. For this reason, she must rely on a surprise attack. A pride of lions will hunt down bigger game than a lion or lioness on its own. Using an ambush, the pride will attack buffalo or giraffe.

Where would you find whirlpools?

Whirlpools occur quite frequently in the narrow sea passages between island groups and mainland shores. They are common in the fiords of Norway, the long, narrow inlets of sea between high cliffs.

What happens is that a rotary flow of sea currents is created by a head-on meeting of a rising tidal current with the returning ebb current of the preceding tide. Usually whirlpools are more likely to occur over a deep or depressed area of the sea bed.

In some cases, particularly between the Sea of Japan and the Philippine Sea, the whirlpool becomes so great that the rotary flow changes to a spiralling downward flow into a deep centre. This is capable of sucking under water objects as large as ships.

Where can you look for precious stones?

Precious stones, or gems, are minerals used for adornment, and they are found in rocks. Rocks are divided into three groups. The igneous (fire-formed) rocks may be fine-grained or coarse-grained; a very coarse-grained type, called pegmatite, is an important source of gem minerals such as diamonds. Gems are also found in the cavities of the igneous rocks granite and obsidian.

Sedimentary rocks are layered rocks and, except for turquoise and opal, are the source of very few gems. However, when the original rock contained heavy minerals - and gem minerals are heavy - pebbles of them tended to be deposited as pebbles in a river bed and such deposits form the gem gravels of Upper Burma, the "byon", and those of Ceylon, the "illam".

Metamorphic rocks - rocks which have been altered by pressure - are a fruitful source of gem minerals, for instance the rubies found in Burma.

There are also precious materials of animal origin - pearls from oysters, ivory form elephants and coral from the tiny sea creatures which give their name to it. There are also amber and jet, whose origin is vegetable. Amber is the fossilized resin of a coniferous tree which grew in the Eocene period. Jet is a variety of fossil wood.

Gems are found throughout the world and are prized for their rarity and beauty. Their charm may depend on transparency and depth of colour as in the ruby and emerald, on colour only as in the turquoise, on purity and "fire" as in the diamond, and on "play of colour" as in the opal.

When is pumice stone formed?

Pumice stone is formed when molten volcanic glass, ejected from beneath the earth's crust, cools so rapidly that there is no time for it to crystalize.

After the pumice has solidified, the gases inside are suddenly released and the stone swells up into its characteristic light and airy form. If the substance had cooled under greater pressure it would have turned into solid glass.

The stones have long been used for cleaning and polishing. Since the Second World War it has been employed widely in railroad building, masonry and insulation. good pumice is found in Iceland, the Canaries, New Zealand, Greece, the Pacific coast of the United States and many other areas with a volcanic background.

Where is Oberammergau?

Oberammergau is a small village in the Bavarian Alps near Germany's border with Austria.

In the winter of 1632 the village was struck by the Black Plague, which spread devastation through Europe. By the following summer one-eighth of Oberammergau's population of 1,000 people had died.

The village elders called all those who could walk to the church and everyone made a vow: "A solemn promise to devote one year in 10 to the preparation and presentation of the tragedy of our Lord's Passion to keep the Christian principal of the redemption of the world before men for all time."

There were no more deaths from the plague, and the villagers believed God had heard their vow.

Apart from an occasional lapse, due in the main to wars, the village people of Oberammergau have presented their Passion Play every 10 years. The first performance was held in the church in 1634. Nowadays a huge theater, looking rather like a great aircraft hangar, is used. It seats 6,000 people and has room on the stage for crowd scenes with 500 actors. Only native-born villagers may be considered for the 600 parts in the play. Selection for the principal parts is made by ballot more than 12 months before the performance. Rehearsals begin in May for the first performance in May of the following year.

The Passion Play has given Oberammergau worldwide renown and visitors travel long distances to see the eight-hour play.
The play is divided into episodes. These episodes are introduced by the Passion chorus, which consists of fifty singers.

The whole community becomes involved in the production in a completely medieval way.

What We See From the Earth?

Is it clear night tonight? Go out of doors.

Look up into the sky. There are stars dotted all over the sky. How many stars can you see?

You might think there are millions. But that would be too many. If you could count all the stars you can see without a telescope, you would find only about 1,500 stars. You would need very clear skies to see all those on one night.

Most stars look quite faint. There are only a few hundred really bright stars. In Cities, the air is smoky. Bright street lights cause a glare that hides faint stars. People who live in cities can see only the brightest stars. But that is all right. You need only know about these bright stars to find your way round the sky.

Many of the bright stars fall into groups. These are easy to recognize. People have given the star groups names.

How do flowers get their different colours?

Nature has given us many different varieties of flowers in different colours. The colours in flowers come from different pigments. Chlorophyll is the pigment which makes leaves green. Likewise the petals of flowers have pigments to make them different colours. For example, the pigment which gives an orange colour is called carotene. Some petals have more than one colour and this is because they contain different types of pigment. Colours may fade or change as the flower gets older.

Who were the Aztecs?

They were ancient American Indians who lived in

Mexico from A.D. 1200 until the coming of Cortes in 1521. The Aztec Indians created a highly advanced and powerful form of civilisation. They built large and well-planned cities, and had organised goverments.

In appearance, they were sturdy people with dark skins and straight, dark hair; in fact very much like the Indians who still live around Mexico. Most of the Aztecs spoke the *Nahuatl* language, from which we have taken such words as tomato, chili and chocolate.

How did Aztecs live?

Outside the cities, the Aztec Indians lived in simple houses made of *adobe* (mud bricks) with a thatched roof. The husband worked in the fields while the wife ground corn and made unleavened cakes called *tortillas.* They would also spin and weave cloth.

Clothes were made from the fibres of the century plant. Men wore loin-cloths, capes and sandals, while women wore short skirts and sleeveless blouses. Many of their clothes were beautifully decorated, and the designs indicated the wearer's position in society.

The chief city of the Aztecs, *Tenochtitlan*, was built where the modern Mexico City stands today. The

Spanish explorer Cortes called the city 'The Venice of the New World', as it was built up from the bed of the lake Texcoco. The city was a wonder of ancient engineering: as well as many canals there were also aqueducts, causeways and movable drawbridges. All the main canals and roadways led to the main plaza or square, where many temples dedicated to the Aztec gods stood. The main government building were situated there as well.

Did the Aztecs have schools?

Yes. Priests trained young girls and boys for official religious duties in special schools called *calmecacs*, and there were also *telpuchcalli* (house of youth) where history, Aztec traditions, crafts and religious observances were taught. But the Aztecs were unable to write; they formed picture-writing symbols on books made of leaves, rolled into a scroll. Some of these survive today.

What was the Aztecs' religion?

The Aztecs worshipped many gods, usually in the form of animals. Their beliefs were so strong that religion dominated even civil laws and decisions. The Aztecs waged war on other peoples not only because of political reasons, but to bring back prisoners of war. Rather a gruesome element in the Aztecs religion was the human sacrifice of these prisoners, often in the most barbaric ways. Alongside the temples in the plaza would stand racks of thousands of severed heads, evidence of the sacrifices. The favourite Aztec god was *Huitzilopochtli*, or Hummingbird Wizard, god of war and of the sun. There were many others: *Quetzalcoatl,* the plumed Serpent, is the most important, the god of learning and of the priesthood.

Where is the highest tide in the world?

The highest tide in the world is recorded in the Bay of Fundy which is between New Brunswick and Nova Scotia in eastern Canada. There the Petitcodiac River narrows, and forces the inrushing tide to the greatest height found anywhere on earth. The difference between high water and low water in the Bay of Fundy is no less than 50 feet. Fishermen make use of these extreme tides. They set their nets at high tide and collect their catch of fish when the tide goes down.

Tides throughout the world are caused by the varying power of the pull of the sun and the moon on the oceans. They draw the water up in a great wave, and the rotation or spin of the earth every 24 hours sends this wave round the world washing the coasts of the continents and islands. The varying shapes of the coastlines and inlets also affect the tides, and, therefore, ports and navigation.

At certain times of the month, the sun and moon are said to be in conjunction - that is, they are pulling in the same direction, which causes tides to be higher. These are called spring tides. At other times in the month, the sun and moon are in opposition, which means they are pulling against one another. Then the tides are lower and are called neap tides.

How are animals threatened?

For centuries, lions have been hunted by people. Lions were driven from the grassy plains that stretched across Europe to Russia, as land was cleared for farmland. In India, the last large group of Asian lions is likely to die out soon, as their safe home in the Gir Forest is threatened and changed by hunters and farmers. Large numbers of lions are now found only in East Africa.

Safari hunters matched their skill and courage against the strength of the lion. They stalked and killed him at close range with powerful guns. Lion skins were sold to make rugs, coats and bags.

Today we realize that many species of wild animal must be protected if they are to survive. Laws have been passed in Africa and India to prevent too many lions being killed. But tribesmen still break the law, setting cruel traps to catch the animals. When such poachers are caught, they are severely punished.

Another major cause of danger to animal and plant life is pollution. This can occur both on land and at sea. As life on land becomes more and more crowded, it is becoming increasingly important that we control pollution with strict laws. We should take care not to destroy the oceans in the same way as we have carelessly ruined large areas of land.

There are strict laws to prevent oil spills, but accidents do happen. Slicks of oil collect on the waves and the tide carries them ashore. They kill plants growing on the sea shore and fish in the water. The feathers of sea birds get clogged and matted, so they cannot fly. They peck at the oil to clean their feathers, and it poisons them. Hundreds of dead fish and birds are washed up on the beaches after a large oil slick.

Where do thunderbolts come from?

Thunderbolts are actually lightning. A thundercloud forms when air carries moisture high into the sky. Raindrops form, and the movement of air currents causes them to be charged with electricity. When the charges become strong enough lightning flashes within the cloud. If the charge cannot be contained in the cloud the lightning flashes to earth with a loud clap, and a tree or other tall object on the ground may be struck and sometimes destroyed.

Occasionally the lightning fuses metal or sand, producing a hard, rough object which the ancients used to think was hurled down from the sky by an angry god. This was the so-called "thunderbolt". The word is now used to describe a sudden or overwhelming occurrence.

Did the Aztecs have money?

No. Instead, they paid taxes and traded in food, clothing, skins, pottery, gold and silver. Taxes had to be paid to the emperor, who ruled supreme over the high council, who elected him. Only military men could attain high rank in Aztec society and all men had to serve in the army. Historians believe the Aztecs were the first Indians to use swords.

Why do some trees grow very tall?

Sunlight is essential to keep plants and trees green and healthy. The surface of green plants and the leaves of trees have to be exposed to sunlight so that photosynthesis can take place. Trees which grow in woods or forests make a lot of shade. Therefore, to obtain the light they need, they grow upwards towards the sunlight. New branches and leaves grow on the upper part of the tree, where there is maximum light. House plants tend to 'lean' towards the light for the same reason.

Some of the tallest trees in the world are found in tropical jungles. This is because these areas have long periods of sunlight and a lot of rain. This abundance of light and water (which feeds the trees with minerals from the soil) produces very rapid growth throughout the year.

Where is the hottest place on earth?

For sheer consistency the hottest place in the world is Lugh Ganane in Somalia, east Africa, where the temperature never falls below about 31° Centigrade (88°Fahrenheit).

However, the hottest temperature ever recorded was in 1933 at San Luis Potosi in Mexico where about 58° Centigrade (136°Fahrenheit) in the shade was recorded.

In California in 1917 temperatures about 49° Centigrade (120° Fahrenheit) were recorded on 43 consecutive days - in Death Valley, not surprisingly.

Western Australia also has more than its fair share of sunshine. At Marble Bar, for instance, the temperature remained around 100° F for 160 days and in 1946 at Wyndham, again in Western Australia, the temperature reached 90°F or more, for almost the whole year (333 days to be exact).

Where is the Everglades?

The Everglades are in Southern Florida in the United States. The peninsula of Florida, low lying and with a climate ranging from warm temperate to subtropical, stretches out from the American mainland towards Cuba. In the south of Florida lies the state's biggest stretch of inland water, Lake Okeechobee. Spreading south from this is the huge wet prairie called the Everglades which, after 100 miles, gives way to the mangrove forests fringing the peninsula's broad tip.

The Everglades have a slope to the south of only two inches to the mile and, along the eastern side of the great prairie, there is a river with an almost imperceptible flow. This river, which is only a few inches deep and 50 miles wide, moves slowly towards the south. Along the west side tall cypresses, hundreds of years old, stand in the Big Cypress Swamp. The whole area is waterlogged, for beneath the peat beds there is a porous rock which soaks up water like a sponge. All this freshwater-soaked land keeps back the salt water of the Atlantic Ocean, and the excess of water flows into the sea.

Grasses grow in the shallow, slow-moving river. Tall cypress trees flourish in the swamps. The area is rich in vegetation and wild life. A primitive world, thousands of years old, continues into the present and the Americans sought to preserve this by creating the Everglades National Park. But in spite of these efforts, civilization is destroying this primitive world. Agricultural land is being reclaimed by draining the swamps. Water is being taken from Lake Okeechobee and diverted from the river to quench the thirst of the Atlantic seaboard cities of Palm Beach and Miami. On the surface, the peaty soil dries out and becomes easily ignited tinder. Carelessly thrown cigarette ends create hundreds of fires.

As the swamps dry out and become barren, Nature's balance is destroyed and the wild life is threatened with extinction. The Everglades may well be doomed.

Where was the first canal built?

Archaeologists believe the oldest canals in the world are those whose remains were discovered near Mandali in Iraq in 1968. They believe these canals are nearly 7,000 years old (about 5,000 B.C.).

In 500 B.C. Darius the Great, the Persian emperor, ordered a canal to be built joining the River Nile to the Red Sea. This remarkable construction was the forerunner of the modern Suez Canal.

Which is the largest flower in the world?

The largest flower in the world is the Giant Rafflesia, which grows in Malaysia and Indonesia. The flower itself may be up to three feet across, with petals up to one and a half feet long and an inch thick. The flower weighs between fifteen and twenty pounds.

Do flowers grow in the desert?

Yes they do, although they grow only after rain, and flower for a short time before the sun dries them up. Desert annuals survive for most of the year as seeds, and their blooms are very brightly coloured to attract insects for pollination. The flowering Cactus plants store water in their thick fleshy stems, and their flowers are also very colourful.

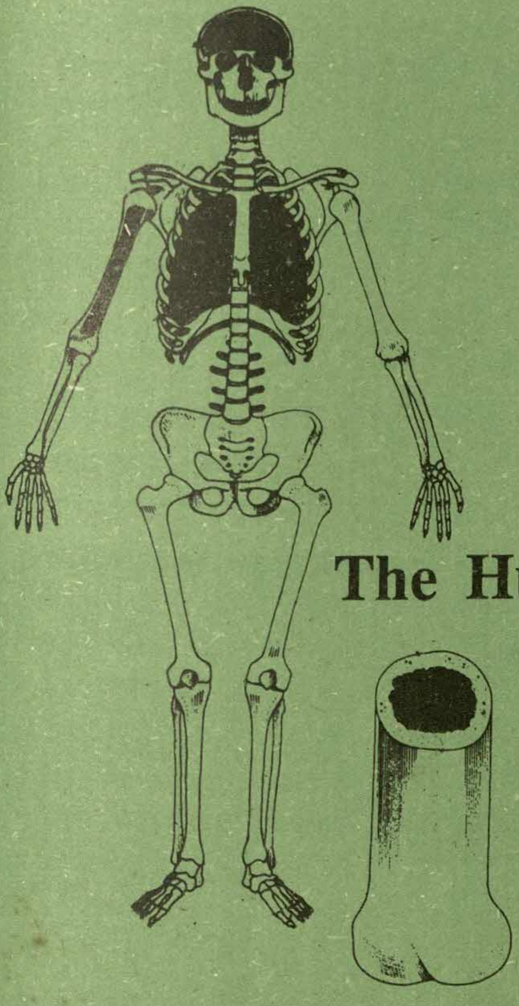
Why isn't mushroom green, like most plants?

Because it is a fungus. Fungi do not contain chlorophyll, which is what gives plants their green colour. Since chlorophyll is needed by plants to make their own food, mushrooms and other non-green plants have to absorb their food from elsewhere, for instance from the soil, which is rich with decaying plants.

On which side of a tree does moss grow?

Usually on the north side. This is because moss likes moist places and obviously there is least sunlight falling on the north side of a tree, making it darker and damper than the rest of the tree trunk.

Deep in a forest, however, where the rays of the sun cannot penetrate, moss may well grow on all sides of the trees.



Chapter 2

The Human Body

When does a heart attack happen?

A heart attack, clinically known as coronary thrombosis, occurs when the arteries leading to the heart are blocked by contraction, a blood clot or cholestrol. In either case the heart will not receive enough blood for it to function properly.

As a general rule the possibility of a heart attack increases with age. But many victims of heart attacks recover completely and go on to lead normal, healthy lives.

Heavy smoking greatly increases the risk of a heart attack. Sudden bouts of exercise in older people can also be risky.

Why does our foot fall asleep sometimes?

Sometimes when we cross our legs for a while we block the blood from reaching our foot, and our foot feels numb. When we uncross our legs and let the blood go through again, we may get a tingly feeling. Why? All the little nerves that "fell asleep" because they didn't get enough blood are now waking up. We can almost feel them waking up and stretching.

Why do insect bites swell?

When some insects bite they also inject an irritant liquid which is deadly for very small animals but has little effect on humans and other higher animals.

When an insect stings a human it usually produces a small swelling. This is the result of a reaction against the toxic liquid, and the bump is formed by a collection of dead, white blood cells.

Where are your sweat glands?

Sweat glands, of which everybody has approximately two million, are distributed all over the body on the skin surface. They are not, however, distributed evenly. The palms of our hands and the soles of our feet may have as many as 2,500 sweat glands per square inch, whereas on our backs there may be as few as 500 per square inch.

Each gland breaks the skin surface in the form of a sweat pore. These pores are too small to be visible to the naked eye, except on the palms and soles, where there are so many that they just become visible.

In some diseases nerve function is lost in certain areas of the body, and these areas also lose the power to sweat. Sweat is a solution of about 99 per cent water with a little sodium chloride (common salt). The body can produce from zero to 2,000 grammes of this substance every hour and even more in strenuous activities.

Why do many people need spectacles for close range when they get older?

As we get older, the lens, which can be pulled thinner or fatter to alter its focus and bring objects at different distances into focus, also ages and loses its suppleness. As change of shape is necessary to see objects about 24 cm (10in) from the eyes, there comes a time

when our arms are not long enough to hold a newspaper far enough away to read it! When this happens it is high time to buy some spectacles for close range reading.

People who are myopic, short-sighted, will then have the advantage for close work. Whilst they will require spectacles for long-range, they will be able to see very well at close range.

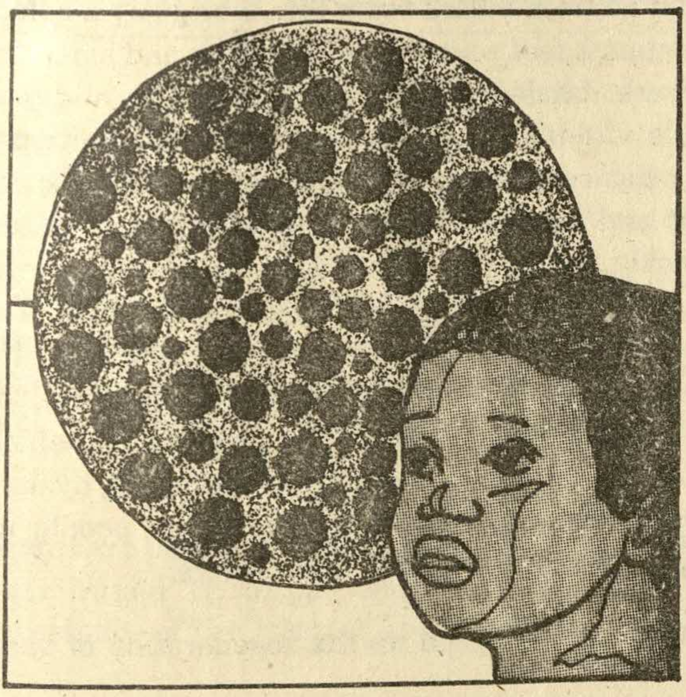
On the other hand, hypermetropes, long-sighted people, are less fortunate. They will require spectacles for both long and close range. The presbyopia (the impairment of vision due to ageing) will be more advanced in these people. To help them, bi-focal spectacles have been introduced. The lenses in these spectacles have one part for long vision and one part for close vision.

Why does your nose run when you cry?

You know that when you cry, tears flow out of your eyes. But they may also slide down a tube that goes from inside your eyes to your nose, and that makes your nose begin to run. That's why some people need to blow their nose when they cry.

What is colour blindness?

People who are colour-blind cannot tell the difference between one colour and another. For example, the



colours red, green and yellow are seen as different shades of grey. Some people may see red as green. This is obviously very inconvenient for them as they are unable to pick out the correct colours of traffic lights and therefore cannot get a driving licence.

This condition was first studied by an English chemist, John Dalton, who was himself colour-blind. This is why colour-blindness is known, in medical terms, as Daltonism.

Why are we dazzled when we go from the dark into the light?

If you go from a dark room into a brightly lit place, you almost feel your eyes a squinting and smarting. You are dazzled, you cannot see shapes and your whole vision is drawn to the light. The reason is that the visual purple in the rods reacts with the light and becomes bleached. It is quickly restored - quickly, but not instantaneously. That is why normal vision is slow to recover after being dazzled. This can be disastrous when driving at night, and if a driver is blinded by headlights, he should slow down immediately, in order not to lose control of his vehicle. Attempts are being made to prevent dazzle, by using special lamps in headlights, but some people are more sensitive to dazzle than others.

In fact, we can speed up the regeneration of visual purple and acquire better night vision with a product derived from vitamin A. Our body does not produce vitamin A, and, if it is missing in the body, it can cause, among other things, problems with vision in the dark.

For many years it was thought that carrots, which contain carotene, were good for the eyes. This is because carotene resembles visual purple. But it only resembles visual purple. Air-pilots, who have sometimes eaten their own weight in carrots to improve their night vision, have scarcely noticed any difference! Only vitamin A is effective.

Where are the Islets of Langerhans?

These islets are not to be found in an atlas but are located in the human pancreas, which manufactures juices to aid the digestion of fats and continues the work of the saliva and gastric juices.

Langerhans was a German anatomist (1847-88) who gave his name to two other parts of the body. He discovered cells in the epidermis called Langerhans Cells and also the Langerhans Layer which is a layer of the skin.

There are many groups of cells without ducts distributed through the pancreas. But the importance of the Islets of Langerhans is that their beta cells are a source of insulin. It is damage to or removal of the Islets of Langerhans that leads to pancreatic diabetes. Insulin, which is a protein, is synthesized by the beta cells.

Why can't we taste food when we have a cold?

When we taste food we are actually tasting it *and smelling* it at the same time. If you can't smell your food, you can't taste it either. Try holding your nose and eating a piece of food. Can you taste it? If you have a cold, you probably have a stuffy nose too, and you can't taste your food very well because the "smellers" in your nose are blocked.

Why do some people get stones in their bodies?

Stones, or gallstones, are made up of various minerals. They form in the gall bladder. It is thought that they are caused by faulty functioning of the liver. Because these stones, or granules, are often rough or sharp, they can cause pain.

People who have these stones usually have to drink a lot of water to flush them out of their system. If they cannot be flushed out, they may have to be removed surgically.

Where do teeth come from?

Teeth are formed from specialized cells which produce the three parts of the tooth - root, neck, and crown. The outer coating of the crown is made of hard enamel. This covers the dentine which forms most of the bony framework of the teeth. Channels in the dentine contain blood vessels and nerves which make up the innermost part of the tooth, the dental pulp.

Most of the higher animals, including man, are born without teeth. they develop two sets, called the milk teeth and the permanent teeth.

A human mouth contains 32 teeth. Their function is to cut, tear, and grind food, and they are specialized for this. So in each jaw there are four incisors (for biting), two canines (for holding or tearing), four bicuspids (chewing teeth with a cutting edge), and six molars (for grinding).

"Wisdom" teeth, the largest of all, are situated at the back of the jaw, and may not arrive until we are grown up.

Where is your funny bone?

Your funny bone is in your arm. It is the long, almost straight bone which extends from your shoulder to your elbow. At the top end it is attached to your scapula, or shoulder blade. At the elbow it is attached to the two bones in your lower arm which are called the radius and the ulna, which in turn are attached to your wrist and hand.

The funny bone carries the very strong biceps muscles - the ones which bulge up on the top of your arm when you bend your elbow and bring your hand up to your shoulder. The bone is grooved to carry the nerves to your hand. These nerves convey messages to and from your brain so that you can control your hand and use it to feel things.

Some people think your funny bone is so called because, when you knock a particular part of your elbow, you get a funny, tingling sensation. The real reason is because the medical name for this bone is the humerus - and since it is pronounced "humorous", the description of "funny bone" has now passed into universal use.

Why do we see the correct image, when our eyes receive inverted images?

Images are projected on to the retina, just like the slides which are placed upside-down in a projector. This is due to the structure of the crystalline lens. But our brain converts everything back to normal.

It is because we know that the sky is high up and the ground low down that the upside-down images we receive are put the right way up again.

The very young baby, however, sees things upside-down. That is why he appears so clumsy when trying to grasp an object he sees high up, which is, in reality, low down! It is only by experience that his brain will convert his vision.

Some volunteers took part in an experiment: they agreed to wear spectacles which made them see everything upside-down. After thirty-six hours, their vision suddenly righted itself. The optical areas of the cerebral hemispheres, which had been 'confused' for a time, corrected the images they received.

After receiving a shock to the rear part of the brain, injured people have had problems with their vision. Temporarily, the optical areas no longer functioned, and the injured were seeing upside-down.

Why do we have kidneys?

Our kidneys perform four function, of which the most obvious is the ejection of waste material containing nitrogen from the body. They also keep the acid-base balance of the blood constant, and regulate the volume of circulating blood and the fluid content of the body as a whole. Finally they regulate pressure relationships between the blood and the tissues.

The kidneys, bean-shaped and about four inches long, lie on the back wall of the abdomen just above the waist, one on each side of the spinal column.

Blood enters the kidneys by the renal artery. Some of its plasma if filtered off and, after other processes, ends as urine. The rest leaves the kidneys by the renal vein to return to the heart. The urine collects in the central cavity (pelvis) of the kidneys, passes down to the bladder via a tube (ureter) and is finally expelled.

A human being can survive without kidneys for only two or three weeks. Nearly one-fifth of the blood pumped out of the heart goes through the kidneys. The Kidneys thus regulate the body fluid - a fluid which Claude Bernard (1813-1878), the great French physiologist, called our "**internal** environment".

When is it dangerous for a male to have mumps?

Mumps can be dangerous for a male after the age of puberty, because the illness can affect the testicles and, in severe cases, cause sterility.

Mumps is a virus infection and it is rare to have more than one attack. The parotid glands in the neck swell and opening or shutting the mouth can be painful. It is possible that only one side of the neck is affected.

Why does our mouth water when we see something good to eat?

The watery liquid in our mouth is called *saliva.* Because saliva is so important in helping us digest our food, we start making extra saliva as soon as we see or smell something good to eat. By the time we actually start eating the food we have plenty of saliva ready to do its job!

Why do we bruise?

We bruise because the body has received a heavy blow which injures the bodily tissues without rupturing or tearing the outer covering of skin.

A bruise is a wound, and a wound may be defined as a breach in the continuity of any body tissue. Often the skin is cut or torn. But closed wounds, such as the rupturing of internal organs, may leave no visible external sign.

A bruise, or contusion of the skin, is caused by the rupture of the blood vessels in the deeper layers of the tissues under the skin. The blood escapes from the damaged vessels into the surrounding tissues and brings about discoloration of skin, which at first goes red, and then "black and blue". As the blood pigments break down, the bruise changes to yellow and green, and eventually fades away. Usually bruises show in the area where the blow has fallen. But there are times when the blood will track along muscles and the planes of connective tissue, causing the bruise to appear some way away from the injury.

What is the uvula?

The uvula is a small mass of muscle covered by mucous membrane that hangs down from the middle of the soft palate at the back of the mouth. The soft palate is a movable fold of tissue and, with the hard palate, forms the roof of the mouth.

The word uvula comes from the Latin word "uva" or grape and the word describes its shape very well. Occasionally, if the throat is infected or relaxed, the uvula may become elongated, but it is never cut, since it recovers it proper size as the condition of the throat improves.

In certain animals, to whom the sense of smell is very important indeed, the uvula is joined to the epiglottis, a leaf-like piece of cartilage which stands upright between the tongue and the entrance to the larynx. This means that the animal is forced always to breathe through its nose. In man there is a gap between the two and consequently food may sometimes accidentally pass into the larynx and windpipe, causing great discomfort. Choking like this can even cause death.

Why is it that we have two eyes, but see only one image?

Each eye is like a camera taking a picture. Like a camera, they too have a diaphragms, which is adjusted according to the intensity of the light. This diaphragm is called the 'iris', which gives the eye its colour: blue, grey, green or brown or any combination. The eyes also have a system that enables us to see things at long or close range. This consists of a lens, which can change its shape to bring objects at different distances into focus. Working like a perfect camera, the eyes have a control centre to regulate eye movement and the size of the pupil, the black dot in the centre of the iris through which light is admitted to the black of the eye. This control centre is found in the brain. It is automatic, therefore unconscious. But the images received on the retina: (the light sensitive film at the back of the eye) have to be analysed, processed and interpreted. This is carried out in a part of the brain with conscious activity: the grey cortex of the cerebral hemispheres, at the back of the head.

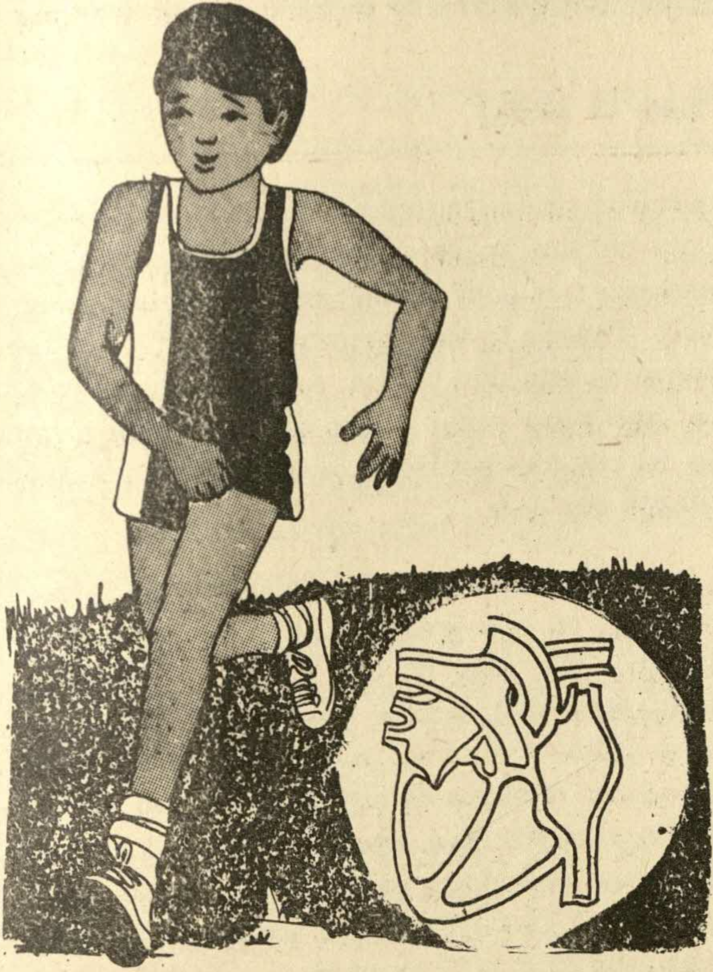
The eye is designed to bring light rays to focus at the retina. The cornea (transparent surface of the eyeball) does most of the focusing.

The images are the visual messages transmitted by the optic nerve. Half of these fibres cross over, so that the pictures sent by the two left-hand halves of the retinas merge in the bottom left-hand optical part of the brain. Similarly, the pictures sent by the two right-hand halves of the retinas, merge in the right hand part. The occipital zone (back of the head) of each hemisphere receives a picture which is a mixture of two half-pictures, and it is here that the complete merging of the messages received by the retinas is carried out.

The purpose of the two images is to give three-dimensional vision. The pupils, the opening in the iris, are about 6cm ($2\frac{1}{2}$ in) apart. Each eye sees an object from a slightly different angle. This spacing between these two sight centres, enables us to see things in relief.

Why does the heart beat faster when we run?

When we run we use a lot of energy. This energy comes from burning up foods, especially fats and sugar. To convert this food into energy the body needs oxygen. For this reason we have to breathe more deeply. The oxygen is carried to the muscles by blood. Therefore, the heart has to beat faster to do this. It is this extra flow of blood that makes our faces go red when we run. Running is very good for the heart and lungs as it helps them to work better.



However, you should make sure that you do not overdo it. If you want to take up running, or jogging, start by running a short distance at an easy pace, then gradually increase it. If you want to be an athlete, you need to do many hours of training.

What is skin?

Apart from protecting our body, skin is a vital element in our physical make-up and well-being. It helps to regularize our body temperature and enables us to sweat. Thanks to the thousands of different nerve endings in our skin we can sense touch, pain, cold, heat and many other subtle sensations. In a minor way we can also get rid of certain waste substances through our skin.

In man the skin varies considerably in thickness according to the area of the body covered. For example, the skin of our eyelids is about one twenty-fifth of an inch or less than 1 mm, whereas on our palms and on the soles of our feet it reaches a thickness of about an eighth of an inch or 3 mm. Human skin has five layers - the basal cell layer, the stratum spinosum (which is several cells thick), the stratum granulosum, the stratum lucidum and, finally, the surface layer which is called the stratum corneum. This can consist of as many as 20 layers of cells but the cells nearest the surface tend to flake off.

Skin is practically waterproof and this quality allows the fluid "body" to live and function in dry air. There are many varieties of skin diseases and the skin also reflects in the form of rashes diseases that attack the body - chicken pox, measles and scarlet fever are examples.

One of the most obvious attributes of skin is its capacity to support hair growth but in man hair on the skin has little practical function or purpose. Hair is continually shed and replaced. The average life-span of the soft, downy hairs is only a few months while the long tougher hairs on the scalp can have a life of several years. Most of the human body's skin is actually covered by hair although for the most part the hair is so fine that we cannot see it without a magnifying glass. However, human beings do not grow hair on the soles of their feet or on the palms of their hands.

In one sense we can be said to register emotions through our skins, since any emotional stimulation can produce perspiration of the skin on the hands, feet and under the armpits.

One of the main functions of skin is to act as an early warning system to the rest of the body about outside conditions.

Skin remains taut and supple during most of our lives, but in old age, when the muscles begin to slacken, it loses this elasticity.

What is the fontanelle?

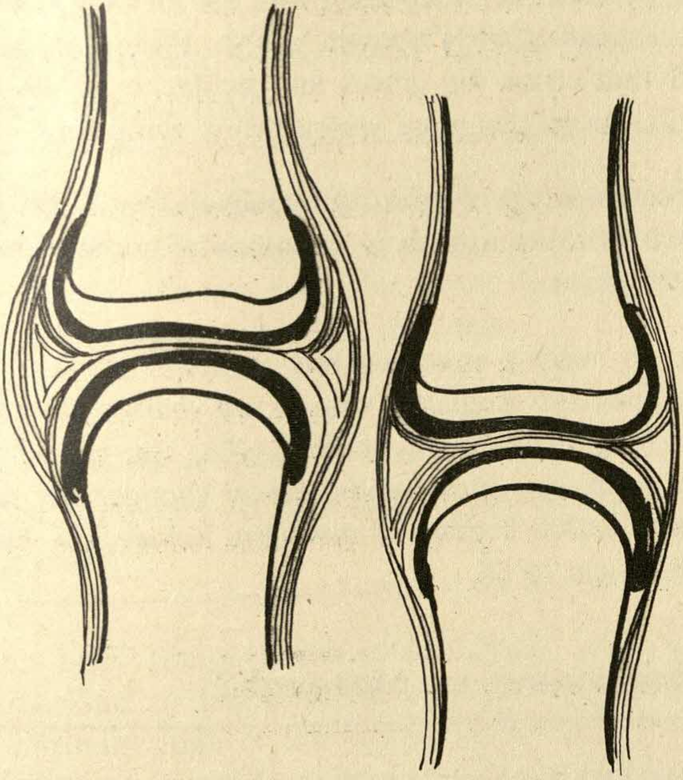
The fontanelle is a gap filled with membrane in the skull of a baby. When it is born a baby's skull is not completely closed and there are some spaces between the bones. The largest is in the front of the head where, at the meeting-point of the frontal bone and the two parietal bones which form the side walls of the skull, there is at birth a gap about one square inch in size. It is called the anterior fontanelle and through it, if you put your hand very carefully there, you can feel the pulsation of the baby's brain.

By the time the baby is eighteen months old the fontanelle has normally closed and, if it has not, some delay in development may be the cause. It may bulge if the baby is ill or feverish or become depressed or sunken if the child is dehydrated. The name comes from an old French word meaning "little fountain".

Why does the knee or ankle swell up if injured?

The swelling of an injured joint, like a knee or an ankle, is caused by the multiplication of normal cells to cushion the affected part. This sudden increase is called hyperplasia. There is also a certain amount of internal bleeding as a result of the injury.

Swellings are divided into two main groups, false tumours and true tumours. The inflammatory swellings that appear after joint injuries belong to the first group, which includes bruises, black eyes, sprains, fractures and infectious swellings such as boils and abscesses. Swollen joints can be eased by the application of cold compresses, or pads, and ice packs. Firm bandages are used to give support.



True tumours or swellings are composed of masses of tissue developed from body cells which already exist. They have a tendency to keep growing. Some of these tumours have normal cells and are said to be benign or harmless. In others the cells are slightly different from their parents and the tumours are generally malignant.

What is a hypochondriac?

A hypochondriac is a person who has an exaggerated preoccupation with his own health. Hypochondriacs will find cause for alarm and evidence of disease or illness in the most insignificant symptoms.

To some extent we are all hypochondriacs. But too much concern can be a symptom of some mental disturbance.

There was a man called Samuel Jessup in Lincolnshire, England, who in 22 years swallowed nearly a quarter of a million pills. His record for one year was 50,000 pills. He is thought to have taken 40,000 bottles of medicine before his death at the age of 65.

What makes us hiccough?

Basically a hiccough is no more than a nervous reflex. Most hiccoughs are the result of shock or indigestion.

A hiccough is a catching of one's breath due to a sudden contraction of the diaphragm, the muscles separating the chest from the stomach. It appears to be a repeated but somehow ineffective and half-hearted attempt at vomiting.

Normally relief is brought about by deep, controlled breathing. This helps the sufferer to regain control of the diaphragm muscle. In very rare cases surgery is necessary to relieve the exhausted patient.

Do children taste food better than grown-ups do?

Children certainly do taste food better than grown-ups do, because they have more taste buds that work. As we get older, some taste buds get worn out and don't work any more.

Why does a doctor take your temperature if he thinks you are unwell?

The body temperature of a human being is an indication of his physical condition, so that an abnormally high or low temperature is generally a sign that something is wrong.

The normal temperature is usually given as 36.9°C. (98.4°F), but as the body temperature varies throughout the day, anything between 36.9°C. (or lower) and 37.5°C. (or 99.5°F.) may be taken, for all practical purposes, as normal.

For instance, the temperature rises after a large meal, during hot weather and after violent exercise. Your temperature is at its lowest at night when you are asleep.

Control of body temperature is exercised by a centre in the brain which ensures that a balance exists between heat production and heat loss. A raised temperature is often the sign of bacterial or virus infection. It may be due to heatstroke, to certain types of brain injury or disease or to shock.

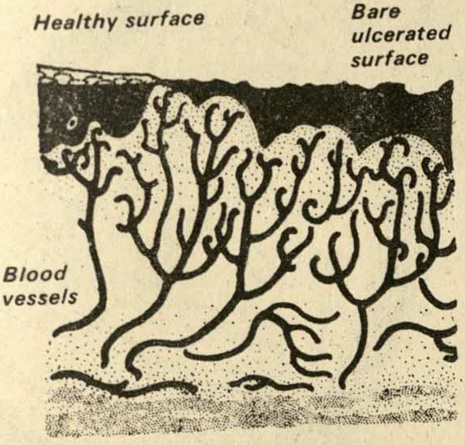
A very high temperature, or fever, may begin with a "rigor" (an attack of shivering and cold), in which the whole body may tremble uncontrollably and the teeth chatter. Although at this stage the skin feels cold and clammy, the temperature within the body is raised. Soon the skin becomes hot and dry, pulse and breathing rate are speeded up and there is a feeling of exhaustion, aching muscles, headache, thirst and perhaps delirium and loss of the sense of time.

Finally this stage is succeeded by profuse sweating and a gradual relief of the symptoms.

When do we get ulcers?

People get ulcers at various times, according to the kind of ulcers they are. Ulcers are wounds or breakages in the skin or tissues of the body.

The least serious are mouth ulcers. They usually arise from some minor infection, or through eating the wrong kinds of food. They are known as benign ulcers. People with varicose veins sometimes get ulcers on their legs. This is because the blood in the skin is circulating too slowly.



If ulcers last for longer than a month, it may be because they are cancerous. These are known as malignant ulcers, and usually have hard edges. They can be dangerous if not discovered at once. The worst kind of ulcers are in the rectum. They cause pain constipation and bleeding, and are difficult to remove if left long.

What is the umbilical cord?

Inside the womb of a pregnant woman or animal a placenta is formed, through which the unborn baby is nourished. The baby is connected to the placenta by the umbilical cord, which is joined to the unborn child at the navel.

The umbilical cord is the baby's lifeline. Everything the child needs to survive will pass through it - air, blood and nourishment. At most it is no more than an inch wide and, perhaps, only a foot long.

Once the baby is born the placenta and all other organs, which serve a purpose only during pregnancy, will be discarded.

The umbilical cord will be cut with scissors a few inches away from the newborn baby's stomach. This is quite painless because the umbilical cord has no nerves. The baby will now breathe on its own.

Why do we need to protect our eyes when out in the snow?

Among the rays coming from the sun, there are some we can see, and some which are invisible. Although the eye cannot see ultra-violet rays as colour, it still receives them. If the rays are too intense, the eye may suffer damage as a result.

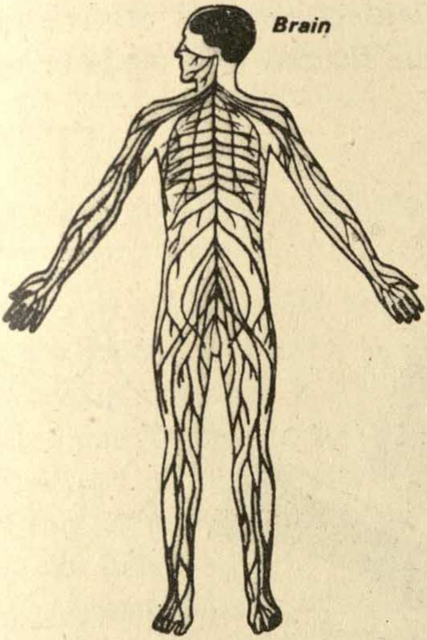
Sunlight on snow is so dazzling, because the very whiteness of the snow reflects back all the radiated light. Part of the ultra-violet rays are also reflected. The snow crystals, with their many facets, greatly increase the number of reflective surfaces. They act as hundreds of thousands of tiny mirrors, which dazzle us.

Good sun-glasses are therefore indispensable to protect our eyes. When selecting these, it is necessary to ensure that the lenses are guaranteed against ultra-violet rays. Simple smoked lenses are almost as bad as none at all. They cut out the glare and the reflexes it causes, that is, blinking of the eyelids, and reduction in the opening of the eye's pupil. At the same time they allow ultra-violet rays to pass through, with the result that the retina of the eye (the sensitive film lining the back of the eye) may be seriously damaged.

The abundance of ultra-violet rays in snowy areas explains why we tan so easily in the mountains in winter. But effective protection of the eyes should be taken seriously. Snow blindness is a painful irritation, which can be fatal for the sight. To avoid this, the Eskimos make wooden or horn spectacles with two very narrow slits, which are just wide enough to see out of, whilst restricting the entry of solar rays as far as possible.

Where are your nerves?

Your nerves are spread all over your body. The organs of the body are composed of tissues. These in turn consist of microscopic units called cells, specialized to perform particular functions such as secretion (glands), contraction (muscles) or conduction (nerves). Likewise the tissues that pick up our nervous system are composed of billions of individual cells located all over the human body. No part of our body is completely insensitive to pain or some other sensation, because nerves are to be found in

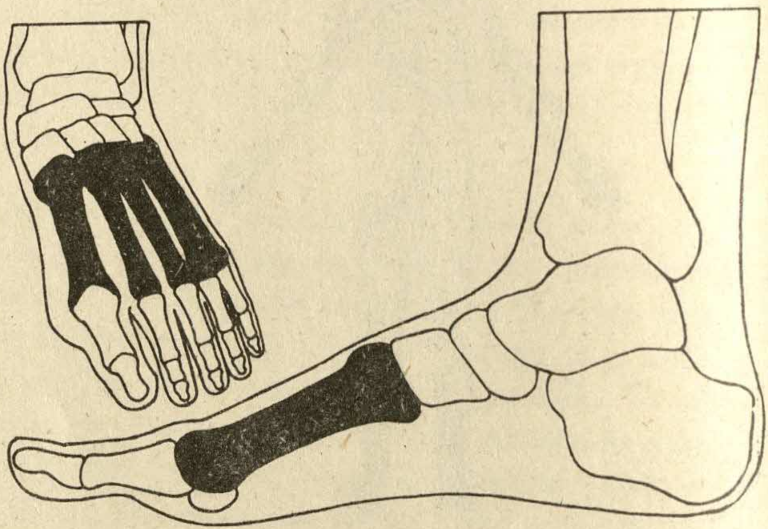


every part of the human anatomy.

The nervous system is usually considered to have two parts, the peripheral or outside system, which is in direct contact with the things that cause pain or pleasure, and the central system, consisting of the brain and the spinal cord. It is in our central nervous system that all our sensations and reactions are finally registered.

Where are the metatarsals?

The metatarsal bones are found in your feet. The foot is made up of the tarsus, or ankle, which consists of seven bones; the metatarsus of seven bones; the metatarsus, which consists of five bones, or metatarsals; and the five free digits or toes.



Metatarsals are short and irregularly cube-like in shape. Their surfaces are rough for the attachment of ligaments. In number and general form they are like the similarly positioned bones of the hand, which are known as the metacarpals.

Although the bones of the feet and hand move in a generally similar sort of way there are, of course, important differences. One of the most obvious differences is that in the bones of the hand the thumb has a far greater play of movement than the big toe in the foot. A joint at the base of the thumb allows many more movements than in the case of the big toe.

This "opposable finger and thumb" is one of the physical attributes that has enabled man to reach the peak of the animal "league" table. It is one of the keys to human development.

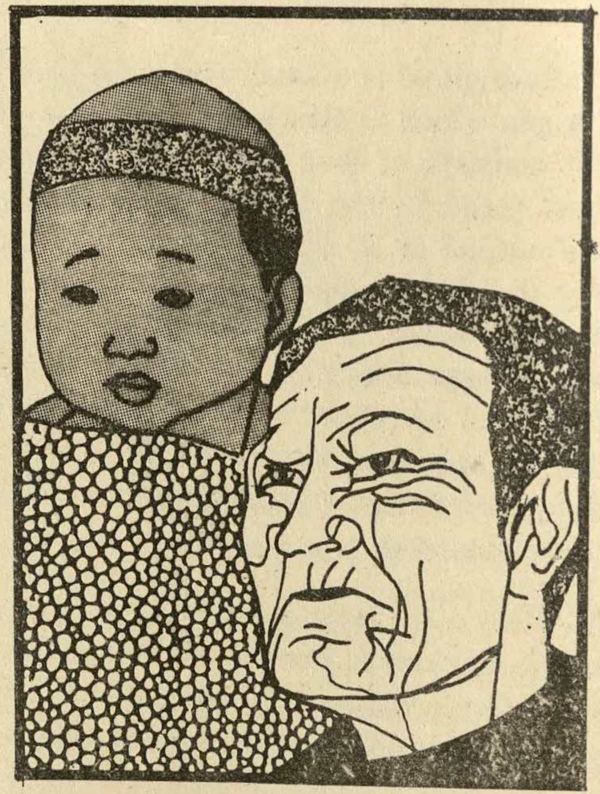
What is the pituitary gland?

The pituitary gland is a small structure about the size of a pea which is attached to the base of the brain. It consists of four parts and is the most important gland in the body for it controls the hormone output of all the other ductless glands, including the thyroid and sex glands.
The pituitary hangs by a little stalk just behind the nasal passage and was named after the Latin word for "nasal secretion" by the Belgian Andreas Vesalius (1514-1564), known as the 'father of anatomy", who mistakenly believed that it discharged mucus into the nose.

If the pituitary is not functioning properly, gigantism or dwarfism may result. Premature old age, extreme thinness, extreme fatness and disturbances in sexual development are other disorders which may occur.

Why do old people have wrinkles?

The smoothness of a child's skin is due to the amount of water contained in the cells of the body. As time passes, those cells are not able to hold so much water. So the body does not replace all the water that is lost through perspiration, for example. This lack of moisture means the skin loses its elasticity and makes the skin shrivel up. This is why old people have wrinkles.



People who live in very hot, dry countries may get wrinkles sooner than people who live in a cooler, damper climate. There are several kinds of creams and lotions which can be put on skin to help keep its moisture and smoothness.

What does our tongue do?

Our tongue does lots of things. It has little bumps on it called "taste buds." They allow us to taste the difference between salty food like potato crisps and sweet food like chocolate or ice cream. Our tongue helps us chew our food by moving the food to where our teeth can bite it. After our food is all chewed up, our tongue helps to push it down our throat to our stomach. And here's something *very* important about our tongue—it helps us to talk.

When would you expect gall stones to occur?

Gall stones occur most often in women who are overweight and have had children, for in the late stages of pregnancy cholesterol, which makes up a large proportion of gall stones, is deposited in the liver in such quantities that the organ may not be able to take it all in. The liver also stores sugar, but overweight people usually take more sugar than they need. So once again the liver may not be able to cope.

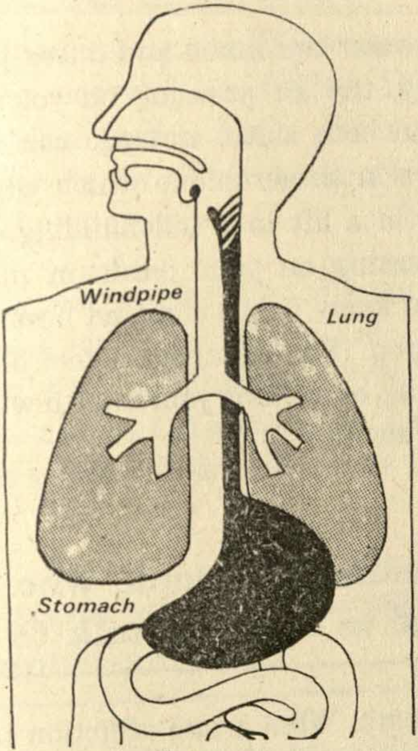
Lying on the underside of the liver, the gall bladder drains the bile, stores it and then conveys it to the intestines. However, if the stones block the tube called the bile duct, or the gall bladder itself, severe pain will result. This is felt under the ribs on the right radiating up to the right shoulder, and lasts until the stone causing it passes out of the bile duct. If the stone is wedged, cholangitis or infection of the gall bladder may occur.

The treatment of cholelithiasis, or gall stones, usually necessitates an operation, for there is no known drug that can dissolve the stones. Drugs can be given to ease the pain and to relax the smooth muscles of the ducts. Often small stones cause more trouble than large ones, which stay in the gall bladder without emerging to block the bile ducts.

Why can you not breathe when you swallow?

You are not able to breathe when you swallow because your respiratory (breathing) system is closely linked to your alimentary (nourishing) system. In fact, both the air you breathe and the food you eat travel down the pharynx, a wide muscular tube situated behind the nose and mouth.

The air must reach the larynx or "voice box" on its way to the trachea (principal air passage) and the lungs, while the food has to go by way of the oesophagus (gullet) and stomach. Obviously, some kind of device must be used to prevent the two



from becoming mixed up.

Swallowing temporarily interrupts breathing by closing the air passages while food is propelled from the mouth to the gullet and stomach. If a particle of food goes the wrong way the lungs respond immediately by trying to expel the food with a cough. Also some air does find its way to the stomach and can, if excessive, cause flatulence or "wind".

Why do our ears "pop"?

You may have heard of the ***eardrum***, a thin piece of skin between the inner and outer parts of your ear. Usually, the air pressing on your eardrum is the same on both sides, and you can't feel it. But when you're in an aeroplane which is taking off or landing, or in a lift in a tall building, the force of the air pressing on your eardrum may suddenly change. You know it has changed because it makes your ears "pop." You can usually feel better at once by swallowing, or opening your mouth wide as though you were yawning.

Is it possible for people who are born deaf to learn to talk to others?

Deaf and dumb. What a sad affliction to be unable to communicate with your fellow human beings. The ears of a deaf person do not transmit any vibrations. Therefore it is impossible for the larynx to copy sounds.

Today, deaf-and-dumb people are trained to use their hands to feel vibrations coming from a person's throat or from musical instruments.

Deaf people can also be trained to produce vibrations, in the same way, from the larynx and mouth. The sounds they utter are vastly improved when the sound waves are shown on an electronic device, which looks like a television set. By looking at the screen, the deaf person can compare the sound waves he makes with the sound waves he is supposed to make. He can then correct his faults. In reality, a well-trained deaf person has a normal voice. But this training calls for much work, whilst learning to lip-read at the same time.

Doctors pay great attention to the sound training of young babies with hearing problems. Poor hearing corrected early can avoid retarded development. A child with normal hearing recognizes and understands sounds at several weeks old.

Why are some sounds pleasant, and others unpleasant?

First of all, it is necessary to know that there can only be sound where there is air to transmit that sound. Any sound is a series of pressure waves in the air. The concentric ripples which you see forming in the still waters of a lake when you throw in a stone are like the sound waves which a sound produces. From all directions ripples of sound arrive at our ears. Sound travels through the air at a speed close to 300 m (985ft) per second. An aeroplane which travels faster than sound therefore moves at a speed greater than 670 miles (1080km) per hour. The acoustic vibrations which give a sound its particular quality may be produced at a rate of 10 to 100,000 per second. The adult human ear can detect sounds that have a frequency in the range of 16 to 20,000 vibrations per second, but ears are best adapted to register frequencies in the 1,000 to 2,000 range.

The outer ear captures the sounds. They make the ear-drum vibrate. The ear-drum is like a small piece of skin stretched across a drum. Behind the ear-drum, there is a chain of small bones (ossicles) which transmit the sounds to another membrane enclosing a coiled canal. In this canal, there is fluid and sensory cells which send the sound messages to the auditory nerve. Each ear has its own auditory nerve, which first arrives in the lower part of the brain, not far from where the optic nerves arrive. Then the nerve fibres divide and partially cross over. They end on the surface of the brain, at the cortex, in the temporal region. Unlike the optic nerves, the auditory nerves cross *after* they have passed into the lower part of the brain.

Sound is measured in decibels. This unit of sound is not easy to come to grips with. It is enough to know that a whisper registers about 10 decibels, a normal conversation 60 decibels, a jet taking off 130 decibels. Over 90 to 100 decibels, the ear experiences pain, and if such sound intensity is maintained, it may result in permanent injury to the structure, and deafness.

When talking about sound, therefore, we have to distinguish the frequency (the number of vibrations per second) and its loudness.

The fact that both the brain and the ear are involved in hearing makes the scientists' task quite complicated. For example, a certain tone may appear quite unpleasant to European ears, whilst Asiatics find it 'sublime'.

It is the combination of loudness, pitch and tone which makes a sound pleasant or unpleasant to an individual.

How does a baby maintain a close contact with its mother?

After birth, the baby needs physical contact with its mother. It needs to hear her voice and feel her presence. Birth is the separation of the baby's body from the mother's, but there are other kinds of relationship which must not be ignored. Although mother and baby become physically separated when the umbilical cord is cut at birth, they still retain a subtle non-physical link. A human being is not only a well-designed physical body - he also has a mind, and very special mental powers. A caring mother 'feels' when her baby needs her attention and the baby responds to the mother's feelings.

Although separated from the body in which he developed, the baby still retains the habits of his

life as a foetus. Just as he used to grasp hold of the umbilical cord and play with it, he now gets hold of a napkin, a piece of cloth or a scrap of material. In this way, he regains the security and tranquility he experienced before birth. If he is also in his mother's arms and can feel her bare skin against his, he experiences total well-being again. Breast-feeding is an excellent half-way stage between birth and the discovery that he is an independent person. Learning to walk will also give him a taste for freedom. But at the slightest alarm he returns to the comfort and security of his mother's arms. This interaction between a mother and baby is called bonding.

The same bonding can take place between an adopted child and the woman who raises him. In this way a deep understanding and a need for affection are satisfied on both sides, by tender care and love.

Why do we have loops and whorls?

The skin's surface is marked by a series of fine lines and ridges which deepen with age. The pattern on the tips of the fingers is peculiar to each individual and is used as a means of identification. In fact, the ridges of the skin on the lower finger joints and the toe prints are also unique, as are palm prints and foot prints. But fingerprints are by far the most simple and effective identification method.

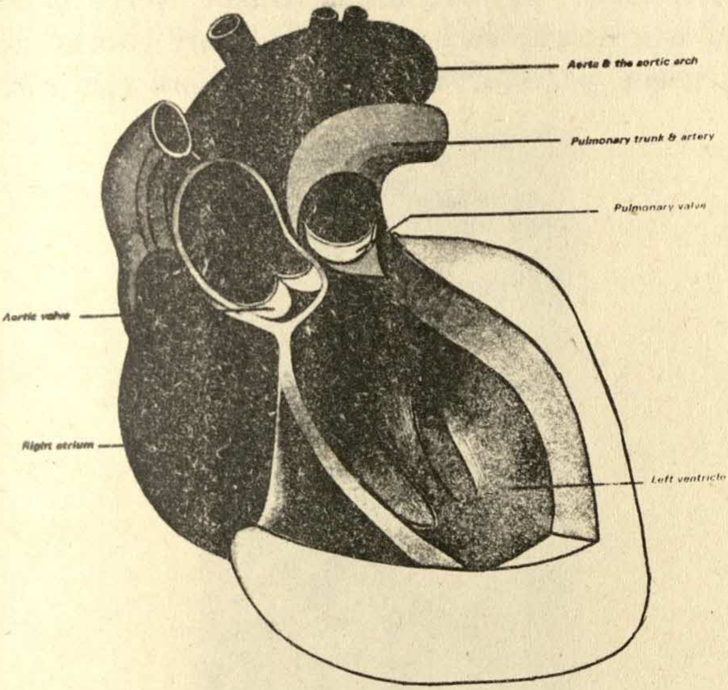
Each ridge of the outer skin (epidermis) is dotted with sweat pores and anchored to the inner skin (dermis) by a double row of peglike objects called papillae. Injuries which affect the epidermis do not alter the ridge structure, and the original pattern returns in the new skin. If the papillae are destroyed, however, the ridges will disappear.

There are five general pattern shapes or types: the arch, the tented arch, the radial loop, the ulnar loop and the whorl. Whorls are usually circular or spiral, arches are shaped like a mound or hill and tented arches have a spike or "steeple" in the centre. Loops have concentric hairpin-shaped ridges and are divided into "radial" and "ulnar" to denote their slopes in relation to the radius and ulna bones of the forearm. Ulnar loops slope towards the little finger side of the hand and radial loops slope towards the thumb.

The pattern on our fingertips remains the same from birth until death, barring deliberate or accidental destruction of the papillae. Fingerprints therefore provide a positive identification, and the practice of fingerprinting (dactyloscopy) is an essential part of police procedure.

The heart - what is it?

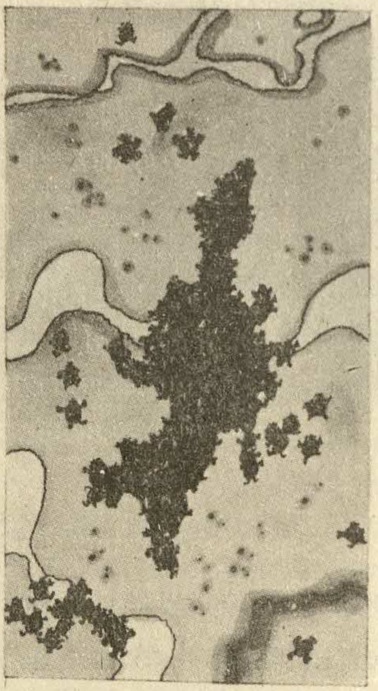
Bichat, a famous French anatomist at the end of the eighteenth century, described the heart as a 'hollow muscle'. The heart is really just a large pouch with walls of solid muscle. But the pouch is double, because the heart has twin halves: two pumps that share a control system and beat as one. The two halves are separated by a thick muscular wall. This wall separates the bright red blood carrying oxygen, on the left-hand side, from the dark-red blood carrying carbon dioxide, on the right-hand side. Each half is divided into two different-sized chambers: these are called the *auricle* (also called the *atrium*) and the *ventricle*. They interconnect through a hole fitted with a valve, which can only open from the auricle into the ventricle. This is called the auriculoventricular valve. The auricles (left or right) are small chambers with relatively thin walls (2mm



[$\frac{1}{12}$ in] on average), compared to those of the ventricle (which are 12mm [$\frac{1}{2}$ in] for the left ventricle and 4mm [$\frac{1}{6}$ in]for the right ventricle). The blood vessels (called 'coronary' veins) empty the blood into the right side of the heart from where it is pumped to the lungs to be reoxygenated. The blood vessels (called 'coronary' arteries) bring a constant supply of food and oxygen to the cardiac muscle cells.

What do the blood platelets do?

The blood platelets are much smaller than the other blood cells. They are round, fragile, very viscous and can stick to each other. There are two to four thousand per mm^3 of blood. They are concerned with the clotting of blood. Clotting is nature's way of sealing a wound and thus preventing prolonged haemorrhage - oozing of blood.



Blood platelets, clustered together, help the blood to clot.

What do the red corpuscles in blood do?

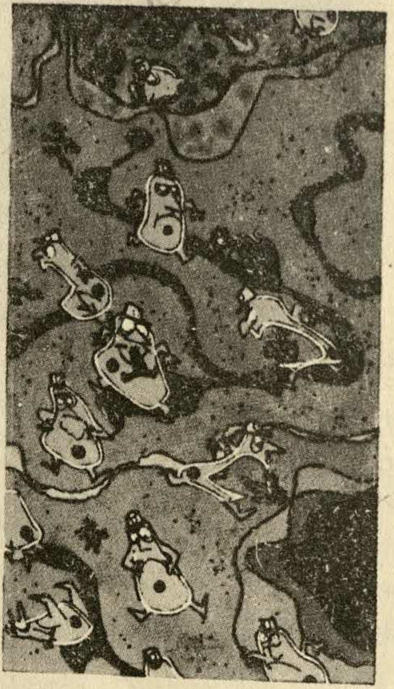
Red corpuscles are cells which have lost their nucleus (the dense centre of a living cell). As a result, they have a limited life and cannot reproduce. In general, they live for three months and are then replaced by 'new' corpuscles, made from the bone marrow. Red corpuscles contain a coloured pigment called haemoglobin. This pigment combines with oxygen on passing through the lungs. The oxygen is released into the tissues from the capillaries and oxydation takes place. Haemoglobin is made up of two substances: globin, which is a colourless protein, and haematin, which is red because of the iron it contains. It is because of its iron content that haematin has

Red corpuscles transport oxygen round the body.

a strong affinity for oxygen. There are about five million red corpuscles per mm^3 of blood. Anaemia is due to a deficiency in quality or quantity of red corpuscles in the blood.

What do the white corpuscles in blood do?

In contrast to red corpuscles, the white corpuscles are colourless and have a nucleus. There are six to eight thousand per mm^3 of blood. They can be



The chief function of white corpuscles is to defend the body against invading micro-organisms.

grouped into five families, according to size, shape, nucleus and function. They are very mobile. They swim by changing shape and chase microbes, which they catch and digest. They are capable of making antibodies to combat antigens. The life of white corpuscles is very short - only two to three days. They are produced by the bone-marrow, the lymph glands, the spleen, the thymus and specialized parts of the intestine. Their chief function is to defend against invading micro-organisms, which they have the power to destroy - and they are continually at war with undesirable substances and wastes, which can pollute the blood.

What are blue babies?

The right-hand and left-hand sections of the heart are usually quite separate. This separation takes place while the baby is developing in the womb. An opening, called the foramen ovale, remains between the two auricles until birth. If this opening, this hole, is not sealed at birth, the dark-red blood from the right auricle mixes with the bright-red blood from the left auricle. This mixture of the two bloods gives a slightly bluish tinge to white-skinned babies. The extent of colouring depends upon the size of hole. As this mixing of the blood causes problems associated with a poor oxygen supply, very delicate operations need to be carried out to seal the hole. You have probably heard such babies referred to as 'hole-in-the-heart' babies.

When does the body produce adrenalin?

A person's body produces adrenalin when he is angry, frightened or challenged, or when he needs to be functioning at maximum efficiency to meet some sort of stress.

Adrenalin is a hormone, a substance which acts upon tissues and organs. It is secreted in the adrenal glands, which lie like a pair of pyramid-shaped caps, one on top of each kidney. Each gland has two parts, the outer shell, or cortex, and the inner core, or medulla. The adrenal hormones come from the medulla and are released into the bloodstream.

They stimulate the liver both to release its sugar and to speed up its manufacture for muscular action. They also contract blood from the skin and raising the pressure at which it is pumped through the brain and lungs and muscles. The heart and pulse quicken, the breathing speeds up, the body heat rises and muscular fatigue is postponed. At the same time the ability of the blood to coagulate in the event of the person being wounded is increased.

This series of defence reactions occurs almost immediately. Adrenaiin released by the glands is reinforced by more hormones produced at the sympathetic nerve ends. A hormone produced in the brain, called serotonin, stimulates the transmission of nerve impulses.

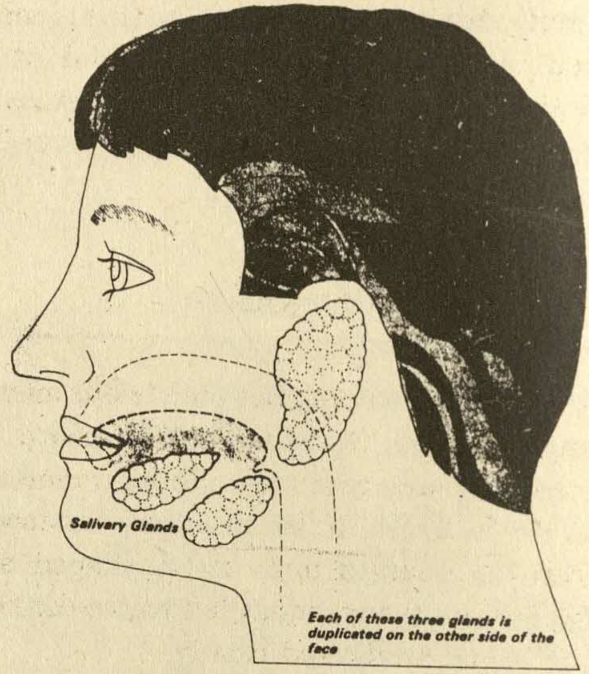
Why do we produce saliva?

Saliva, the watery secretion produced in our mouths, has many functions. It moistens the mouth and tongue, making sure that the mucous membrane does not dry or crack. It also moistens our food so that it can be moulded into an egg-shaped mass (or bolus) for swallowing, and it lubricates the bolus so that it can be swallowed easily.

By means of the enzyme ptyalin, which it contains, saliva begins the digestion of carbohydrates in side the food. Saliva also acts as a solvent to make tasting food easier, for the taste buds are stimulated only by dissolved substances.

It is a cleansing agent, washing away particles inside the mouth. If salivation is stopped, for instance in the case of a high fever, the mouth becomes dirty and tastes and smells foul. If salivation slows down, our mouths feel dry, and we know we need water.

Saliva is secreted in the three pairs of salivary glands. The largest of these are the irregularly shaped parotid glands which are packed tightly into a space


Salivary Glands
Each of these three glands is duplicated on the other side of the face

between the ear and the top of the jawbone. The glands are encased in an inelastic covering and that is why they are extremely painful if they swell. The next pair are the submandibular glands which are eggshaped and lie under the front of the jawbone, and the third pair, the almond-shaped sublingual glands, lie on the floor of the mouth between the tongue and the jawbone.

Why do children's voices sound smaller than adult voices?

Inside our throat are folds of skin called *vocal cords.*

We don't have to think about it, but we make sounds by pulling the vocal cords together and letting air from the chest come up and pass over them. A child's vocal cords are shorter and thinner than a grown-up's, so a child's voice sounds smaller than a grown-up's voice.

When do people stop growing?

People stop growing when their bones do, and that is usually between 15 and 25 years of age.

Bones are made up of living tissue, composed of special cells which secrete round themselves material rich in calcium salts and as hard as marble. The formation of bone (ossification) is a complex process which usually begins in cartilage (gristle).

In a child the bone begins to form in the middle of the cartilage and spreads towards both ends, turning it all to bone with the exception of the tips. From these points the bone grows in length and so does the child. When the growing period is over the tips of the bones close by joining the main shaft of the bone.

Bones vary greatly in shape and size. Long ones act as levers. Flat ones are centres for muscle action. But each has a cavity containing bone marrow. Around this the bony substance is spongy in texture, becoming hard nearer the surface where the calcium is densest. On the surface of the bone is a special layer of fibrous tissue (the periosteum) which is rich in bone-building cells.

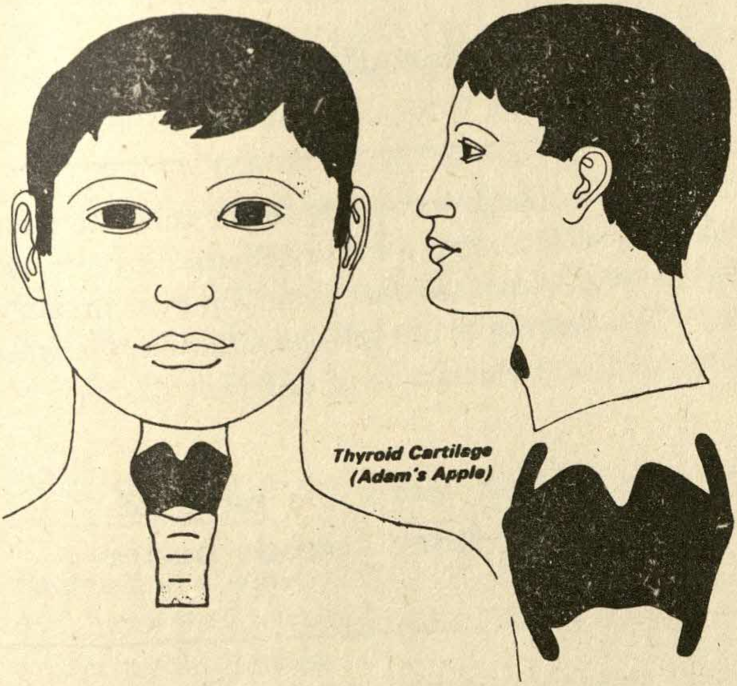
Why do old people have grey hair?

The colour of the hair is produced by a substance called melanin. This is the same substance that produces the colour of skin and protects it from the Sun. As time passes and a person becomes older, less melanin is produced. Therefore, the hair begins to lose its colour and becomes grey. This can happen

even before old age. Illness or a very bad shock or emotional experience can cause hair to go grey. In some families, people tend to go grey early, just as in some families men tend to go bald early in life.

Why do men have an "Adam's apple"?

An "Adam's apple" is to be found in both men and women and is part of the larynx, or "voice box", situated at the top of the windpipe in front of the neck. The larynx is a more or less rigid box created by a framework of cartilages connected by ligaments. The most important of these cartilages is the thyroid



forming the prominence called "Adam's apple". The others are the cricoid cartilage and the epiglottis. The vocal cords are suspended in the larynx. These are two fibrous bands which are anchored fore and aft.

The chords are heavier and thicker in man than in woman, which makes the thyroid cartilage more pronounced. This led in olden times to the wrong belief that the "Adam's apple" was only to be found in man. The term itself arises from the ancient belief that it marks the place where the apple given by Eve to Adam got stuck!

How many different colours can we see?

If you have a large set of crayons or coloured pens, you're used to seeing a lot of colours. But you can see more shades of colours than you ever dreamed you could. Your eyes can tell the difference between thousands and thousands of different shades.

Why do people who are hard of hearing hear some sounds better than others?

In old people, or people who are subjected to too loud sounds, the cells lining the coiled canal in the inner ear suffer injury. The first cells to be affected are those at the start of the canal. They have the special function of reacting to certain frequencies. From the start to the end of the canal, the sensitivity ranges from 20,000 vibrations per second to 20 vibrations per second, on average. In people over the age of forty there is loss of 160 vibrations per second, beginning at the start of the spiral canal of the inner ear (called the 'cochlea'). And so, low sounds are heard better than high-pitched sounds.

But hearing is also connected with heredity: a 'bad ear' can be passed from one generation to the next. Fortunately, the same applies to 'good ears'. In short, good hearing is preserved by avoiding exposure to very loud noise for too long. It has been observed that fans of 'pop' concerts, where poorly-adjusted amplifying systems have allowed sound levels of up to 118 decibels, may become deaf. Fortunately, some halls are equipped with audiometers, which show when the sound is too loud and likely to cause damage to ears and hearing.

Why do some men go bald?

Baldness is absence of hair on the scalp. It affects men more than women because male hormones play a part in the process of balding. Over a period of time, greasy substances build up in the tiny blood vessels that feed the root of the hair. This slows down, or stops, the flow of blood to the root which weakens the hair and causes it to fall out. Some men whose bodies produce a lot of the greasy substances begin to lose their hair when they are quite young.

Why do we have bones?

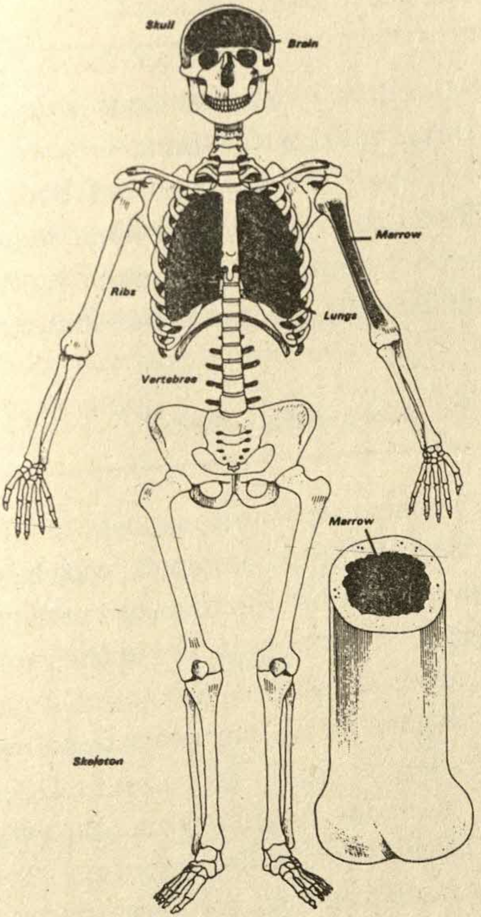
We have bones to give us shape and support the body, to protect and contain the body's delicate vital organs, and to help us move about.

Bones are made from living tissue, composed of special cells which secrete around themselves hard material rich in calcium salts. In a child the bones are soft and cartilaginous (Cartilage is gristle, the elastic substance of the ear or nose). Bone-making, or ossification, is a gradual process. A baby has as many as 270 bones, but an adult only 206, for some bones grow together as they get older.

All bones have a middle cavity filled with a yellow or red fatty substance called bone marrow, the blood-making factory of the body, which also keeps bones light without reducing their strength.

The basic part of the skeleton is the spine, which has 33 bones or vertebrae. The spine carries the weight of the body, is extremely flexible and contains and protects the delicate spinal cord. The skull shelters the brain while the ribs protect the heart and lungs.

Bones fit together at the joints and are held firm by ligaments, which are made of tough tissue like cords or straps. Inside each joint is a thin membraneous bag which secretes a lubricant to make the joint move smoothly.



Some glide on one another, as the lower jaw slides on the upper. Some, such as the elbow and the knee, hinge on each other and others, like the hip, make a ball and socket joint. Bones are sometimes fused together and immovable, as in the five large, lower vertebrae called the sacrum.

What controls our senses?

The control centre of all our senses—taste, smell, sight, hearing, touch, and balance—is our brain. For example, our eyes let light into our body, but it is our brain that actually works out what we are seeing. Sometimes our brains are compared to computers, but our brain is really much smarter than a computer!

Why does pale skin tan?

About 5 per cent of sunlight consists of ultra-violet radiation. Most of this radiation, which can burn in too large doses, is fortunately reflected back through space by the upper layers in the atmosphere. That which manages to pass through the protection of the upper atmosphere, has a very beneficial effect. It helps our skin to promote vitamin D formation which is so vital for healthy skin. But we do not require too much ultra-violet radiation. And so the skin protects itself against too large doses through producing a dark pigment, called melanin.

When exposed to the sun or a sun-lamp, pale skin becomes tanned. brown skin becomes darker. This must be done in stages, to avoid burning and to allow the mechanism which produces the tanning pigment to start working. The pituitary gland, which is suspended from the base of the brain, secretes a hormone which stimulates the production of this pigment.

It is clear from this that we tan to a greater or lesser extent, depending upon our capacity to make this pigment. We can help the body with special creams or tablets. But it must be remembered that the pigment which causes tanning also causes a thickening of the skin at the same time. We have to choose between a deep tan and a thick skin, which risks becoming wrinkled more quickly, or a light tan, enough to protect us and to keep skin attractive!

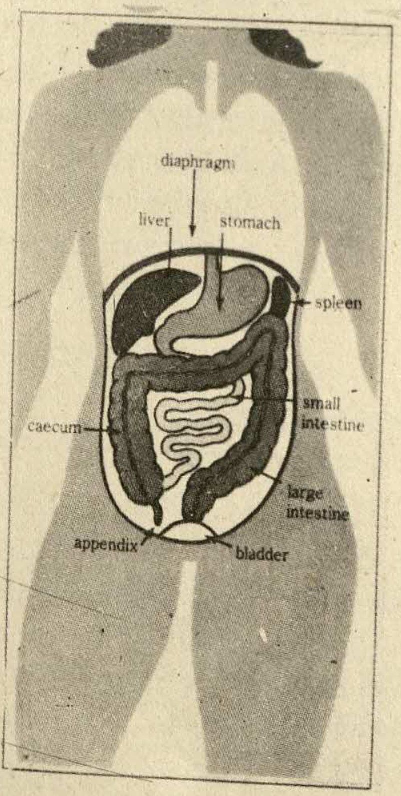
Why do we feel sleepy?

During the day we use up a lot of energy which makes us tired at the end of the day. That is why we need to sleep at night. Whilst we are sleeping, the activity of every part of the body slows down and the whole body gets a deep rest. In fact, not only the body becomes rested, but also the mind. A good night's sleep gives us back energy so that we can work and play the next day.

Small children also need a rest during the day as they cannot store as much energy as adults. When we feel sleepy it means we need a rest.

What is the spleen?

The spleen is an elongated organ weighing about 200g (7oz) in an adult. It is purplish-red in colour and located beneath the diaphragm (a fibrous muscular membrane which separates the abdominal



cavity from the chest cavity), above the stomach and beside the left kidney. The spleen can contract and dilate by means of muscular fibres in the walls which divide it up into small compartments. These muscular fibres give the spleen great elasticity. It can hold up to ten times its own weight in blood.

What are our senses?

Our senses are all the parts of our body that tell us what's happening around us. For instance, we see with our eyes, hear with our ears, feel with our skin, taste with our tongue, and smell with our nose. All of our senses work together with our brain to let us know what's going on outside our body.

When does blood congeal?

Blood congeals when a part of the body is wounded. If it failed to congeal the injured person would die from loss of blood.

The congealing, or coagulation, of the blood, is the first step towards healing a wound. It closes the wound and builds a scaffold for new tissue by means of a chemical process in the plasma, the fluid part of the blood. In this process the platelets (small cellular bodies in the blood) produce thromboplastin. This changes fibronigin, a protein in the blood, into fibrin. Finally a spongy network of fibrin connects the edges of the wound and prevents the loss of any more blood cells. Often, a scab if formed over the wound as a protection.

Why don't babies have tails, like monkey's?

It has been proved that the main use of an animal's tail is to maintain balance. In the case of monkeys, who have long tails, it helps them move from tree to tree. This is very useful for them, as they live in trees and find food there.

In primitive times, man may have lived in trees. According to some experts he had a tail which he used in the same way as monkeys use theirs. When man adapted to walking upright and living on the ground, he no longer needed a tail. Therefore, as man progressed and developed, the tail disappeared. This explains why, today, man has only the remains of a tail; that is, the small bone called the coccyx at the base of the spine.

How do certain viruses get into our body?

Viruses are minute living organisms which consist of near naked nucleic acid (DNA). Once they gain entry into living cells, they become dangerous and capable of reproducing themselves. They cause many diseases, such as influenza, measles, poliomyelitis. In fact, once they have found a warm, moist place, rich in nutrients and biologically useful materials, viruses can create havoc in the orderly running of the body.

Only the largest viruses can be seen with an ordinary microscope - an electron microscope is required to 'see' the majority. Individual viruses show a preference for certain tissues and locations in the body. Fortunately in most cases, one virus infection gives immunity for life. This is because the human body is able to identify the harmful virus and manufacture a chemical, called an antibody, to attack and neutralize it. The snag is that some viruses, in particular cold viruses, remain one jump ahead and nobody has managed to find a cure.

Sometimes viruses need an 'agent', such as a bacterium, when they are taking over a cell. Some scientists have had the idea of suppressing the 'agent', the 'bridge' between the virus and the cells, by repeated vaccinations. Vaccination is a method of providing protection against illness by introducing diseased or dead germs into the body. The body is then forced to produce antibodies, which are harmful to microbes. The vaccination sometimes 'smarts', because the germs are inserted by a needle (given by injection).

There is no doubt that the battle against viruses is a very tough one, because they are rarely affected by medicines. It is amazing to think that during all the time that human beings have been suffering from colds in the head, no one has been able to find a cure!

What makes eyes different colours?

What a baby is going to look like depends on the 46 genes in his body cells. Half of these genes he inherits from his mother, and half from his father. Some of these genes determine his eye colour.

All eyes contain blue cells, but some people have other coloured cells as well so that their eyes look green or grey or brown or hazel. Babies all have blue eyes because the other cells, if there are any, do not grow until the baby is about two. Sometimes people have eyes which are partly blue and partly brown or green. This is because half of their eye has only the usual blue colour, while the other half has some other colour as well.

When two blue-eyed people have a baby only blue cell-genes are being passed on, so all their babies will have blue eyes. But when one parent has brown eyes, a mixture of blue and brown eyes is being inherited, and the colour of the babies' eyes will depend on whether there are enough brown genes to dominate the blue ones. Even two brown-eyed parents may not have enough brown genes between them to have a brown-eyed baby.

What makes you yawn?

When you yawn, or when you see somebody else do so, it is a sign of great need. That need is for more oxygen in your lungs. When you have been sitting in a room where the air has become stale your body cries out for oxygen to cleanse and purify your blood - and the quickest way to supply that need is to open the mouth wide and gulp air.

Better still, you should get out into the fresh air and breathe deeply. You will then find that the need to yawn will vanish, because you are getting a better supply of oxygen.

You must have noticed that you sometimes yawn when you are tired. This means your body-cells need renewal, and your blood needs help in its continual task of reaching and restoring the farthest parts of your body. It indicates oxygen-hunger. Going to sleep not only rests the body, but sets up deep rhythmic breathing which satisfies this hunger.

Why should you yawn when you are bored? You are probably not breathing deeply and feeding your lungs as you should. Of course, the ideal cure is to escape from what is boring you. If that is not possible, try breathing deeply. This will not get rid of the boredom, but it will tend to stop the yawning.

What makes you able to speak?

Babies can babble almost as soon as they are born. Later, they learn the names of objects by copying their parents. Being able to speak sense, and producing sound from the mouth, are two different things. Over the centuries speech has become more complicated. We are able to say more, because man's intelligence has developed.

But our apparatus for producing the sound itself is still simple. The sound is made by means of vibrations of the vocal cords. These vocal cords are two bands of elastic tissue in the larynx, a valve guarding the entrance to the windpipe in the neck. When air is taken in and out, the vocal cords rub together and part again. Puffs of air escape rhythmically from the larynx into the cavity behind the mouth and the nasal passage, and then out by the mouth and nose, producing a tone. A man's vocal cords are longer than a woman's so his voice is lower. By moving our lips and tongue in different ways, we are able to pronounce the particular words we want to say.

The attempted speech sounds of babies of all nationalities sound very much the same. The actual sounds they ultimately fashion into words depends on the sounds they imitate from their parents.

How does the skin protect us from germs?

The skin provides a tough waterproof covering for the body. It is a protective barrier between the outside world and our own internal world. It protects us against germs which could otherwise enter our body and thrive there, and is a very effective barrier, provided that it is not damaged by wounds. First of all, there is a layer of hard, dead cells, which it is almost impossible for germs to pass through. Then there are secretions such as sweat, which is secreted by sweat glands through the pores of the skin, and sebum, the oil secreted by the skin. Both remove waste products.

Sometimes the skin has small pimples. These form if the sweat is not sufficiently acidic to kill the germs, or if the pores became blocked. They may also form around the root of a hair, where the germs have entered via the hair shaft or follicle into the dermis. This is why it is important to keep the skin clean. It is recommended that slightly acidic soaps be used, particularly on delicate skins, which are prone to pimples and easily attacked by germs.

Quite often, pimples are a sign that an organ is not functioning properly. The blood which feeds the skin with good things, also carries waste products. But there are also toxic substances which irritate the skin. And an irritated skin is sensitive to germs. To keep your skin in good condition, take good care of its general state, keep a check on the excretion of waste products, drink plenty and wash well.

What makes people faint?

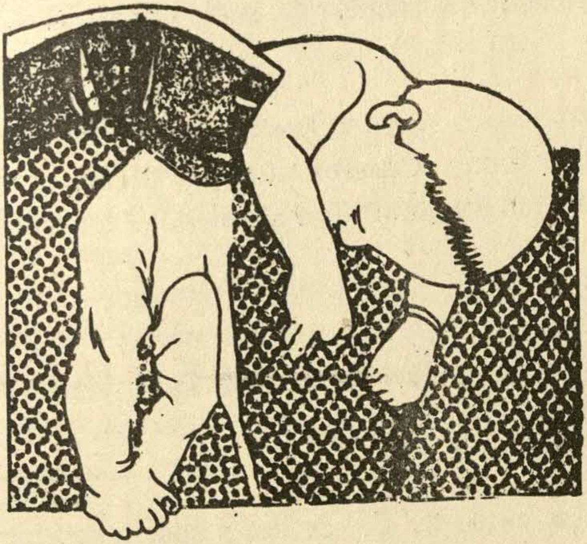
The most urgent need of the body - more important even than food or drink - is oxygen, which is found in the air we breathe. When we breathe in, the oxygen is absorbed through our lungs into the blood by the veins and arteries with the heart working as a pump. The most important place for the blood and oxygen to reach is the brain which controls the rest of the body through the nervous system. If the brain does not receive enough blood and oxygen, it can no longer control the limbs, and the person's legs give way under him in a faint.

There are all sorts of ways this could happen. It might be due to something blocking the blood flow, a tight collar or some more serious cause. But fainting is mostly due to stuffy atmospheres, lacking in oxygen.

If a person with you faints, get the victim into the fresh air, loosen the clothes and put the head between the knees, so that the weak blood supply does not have to climb upwards into the head, but can run downwards. Usually the circulation will get going again quickly and the person will soon come round, with no damage done.

Why are newly-born babies so wrinkled?

The baby grows in the womb for nine months. This is called the gestation period. It is quiet and dark there, and he feels warm and comfortable. So, when he is born, the light and sudden movement of his



new surroundings may frighten him, and make him feel unsafe. He usually screws up his face and cries, which makes him look wrinkled and not very pretty. The skin on his body looks wrinkled too because it hasn't yet absorbed enough moisture. However, he soon fills out and his skin becomes smooth.

What is jaundice?

Jaundice is a condition in which the skin turns yellow because bile pigment is being deposited in its deeper layers.

Jaundice may arise from the breakdown of red cells in the bloodstream; because the bile passages from the liver are blocked so that the bile is re-absorbed into the bloodstream (as in gallstones) or because of disease of the liver cells, as in hepatitis or yellow fever.

Hepatitis and yellow fever cannot be cured by medicine alone. Careful nursing, plenty of rest, a protein-rich diet and time are needed for a complete cure.

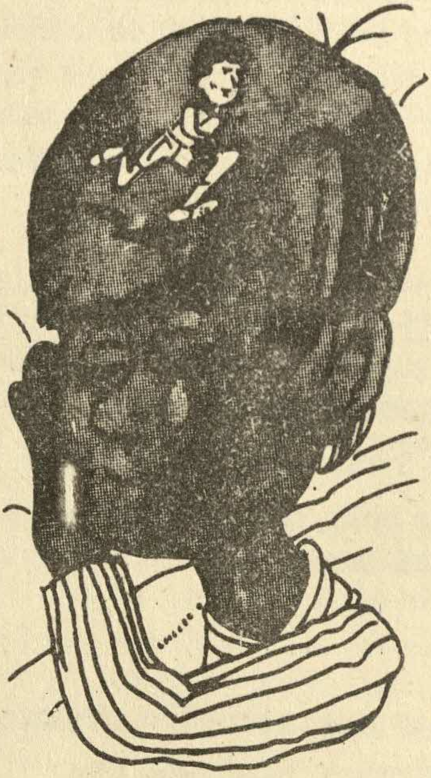
Why does a woman get fat when she is expecting a baby?

A baby is made by the father's sperm joining with the mother's egg and fertilising it. This is called conception. The baby grows inside the mother in a kind of bag called the womb. As the baby grows and gets bigger, the mother's stomach swells. This is why the mother gets fatter when she is expecting a baby (that is, when she is pregnant).

It takes about three months for the baby to become completely formed. In this time the mother does not get much bigger. But, as the baby grows to his full size, the mother's body expands. Most babies weigh at least 3 kilograms (6 ½ lbs) when they are born. After the birth, the mother goes back to her normal size and shape.

Why are we not actually running, when we dream that we are running?

The movements we make to walk, get hold of things, even to scratch the end of our nose ... are controlled by nerve impulses coming from the grey cortex of the brain. These instructions are transmitted by a nerve impulse, a kind of electrical current, which passes at a varying rate through the white nerve fibres in the brain, the brain stem, the spinal cord and nerves going to the muscles.



When we dream that we are running, rock-climbing or swimming, a part of the brain stem concerned with movement sends out a message damping down all the main muscles of the body. This means that any movement instructions the brain is sending out during a dream do not get beyond the brain stem.

We move in our sleep, we turn over, our limbs twitch and our eyes are very active while we are dreaming. But the movements we are dreaming of are completely neutralized. Sometimes, the instruction suggested in a dream is so strong that the centres in the brain stem are momentarily overwhelmed by the strength of the nerve impulses. In this instance they allow part of the instruction to get through, but this has the effect of awakening us immediately.

In young children, the nerve centres are not fully operational. They are still not quite 'mature'. They allow some slight movements to escape, resulting in sleep-talking or laughter. This also happens in adults, but less often.

Why are wisdom teeth so called?

Wisdom teeth are so called because they do not usually appear until the age of 18 to 20, by which time people were supposed to have become wiser. But surveys have shown that at least 19 per cent of the population of central Europe have failed to cut one or more wisdom teeth.

These teeth are the third molars and help in the process of grinding and chewing food. There should be four of them right at the back of the mouth next to eight other molars. Nearer the centre of the mouth are the eight bicuspids (or premolars) followed by the four cuspids (or canines) which are used for cutting and tearing food.

The eight front teeth, or incisors, are used mainly for biting and cutting, while the upper ones enable them to identify objects by nibbling.

Why are needle pricks on the fingertips more painful than those on the buttocks?

The deeper parts of our skin conceal sensory nerve cells that are sensitive to heat, cold, pressure, and pain. All these tiny nerve cells send message to the brain about the sensations they feel. Some of these are not as deep as others. They are particularly plentiful in the fingertips, the palms of the hands and the soles of the feet.

Now you can see why a small needle prick on the fingertip, which has a lot of nerve cells near the surface of the skin, hurts more than a needle prick on the buttock, which has far fewer nerve cells. If you are lucky, a needle can even go in to the buttock without touching them!

When does the brain begin to decline?

The brain begins to show signs of decline after a certain proportion of the nerve cells or neurons of which it is formed have died. The age at which this happens varies.

A grown man has no more nerve cells than he did when he was born. These cells do not multiply as the body grows, as bone and skin cells do. Indeed, as a person grows older he has fewer and fewer nerve cells, because those destroyed are not replaced.

At the age of 70 or 80, as many as a quarter of the nerve cells may have died. That is the reason some old people cannot hear well or have poor memories. Yet others manage to retain their faculties and abilities until they are very old. Recent techniques have made it easier for scientists to study how our brains function, but there is still a great deal to discover.

Is it true that our skin is renewed every seven years?

The skin is made up of hundreds of thousands of cells, arranged in layers. These layers are called the 'dermis', the lower layer, and the 'epidermis', the upper layer. Between the dermis and the epidermis there is a layer which produces new cells, called the 'growing layer'. this growing layer provides all the cells for the upper layers. It is constantly renewing the cells on the surface, which die, flatten, cornify and flake off. No, we do not shed our skin like snakes. But, thanks to this growing layer, our skin is continuously being replaced. However, as we get older, the cells are not replaced as quickly. The dermis is less rigid, and the epidermis sags on to the soft dermis. The muscles beneath the skin are not as efficient as they used to be. Wrinkles appear on the face, and, on other parts of the body, the skin starts to sag and looks dry. These are normal signs of ageing.

What is pus?

The pus we see oozing out from a septic cut is made up of the dead bodies of white blood cells which have fought against the infection.

These white cells, or corpuscles, live in the blood and float around the body ready to fight infection. There are at least five kinds of white cells. The ones which fight the kind of infection that happens when a spot or a cut goes bad are called leucocytes. A speck of blood, the size of a pinhead, normally contains about 5,000 leucocytes. But it may have 30,000 in a really bad septic wound. This is because the leucocytes gather at a point of infection and multiply.

Antibodies in the blood help to fight bacteria. When these have killed the bacteria, the white cells move in to destroy them. If a doctor suspects that the blood may not contain enough antibodies to counteract the infection, he prescribes extra antibiotics, like penicillin, which do the same job.

Often the infection is defeated even without help from injections and pills, but not before many of the white cells have been killed, and discarded as pus.

When do people get hay fever?

People get hay fever when they are allergic to small particles existing in the air. The most common causes are the pollens of certain plants. Therefore the hay fever seasons vary greatly in different parts of the world according to the vegetation present.
In North America ragweed is the worst offender, causing a great deal of distress in late summer and early fall. In Britain, pollen from timothy grass causes hay fever in spring and early summer.

Other causes are dust, animal hairs, moults and, of course, hay itself. Particles of these substances inflame the membranes of the sufferers' eyes and nose.

Temporary relief is sometimes obtained from antihistamine tablets which prevent a certain amount of inflammation in the nose. The most effective treatment is immunization by a series of injections of pollen extract. Many sufferers get relief from this.

When do we need sleep?

By means of experiments and observation, scientists have pin-pointed the area of the brain responsible for sleep. But this sleep centre is not isolated from the rest of the body. It is affected by nerves and hormones. The grey cortex of the brain, the seat of our thoughts, reasoning and reflexes, acts on the sleep centre. People who have something on their mind, well know the problems of getting to sleep. Substances manufactured in various parts of the body (adrenal glands, groups of cells in the bone marrow, the spleen and the intestine) can stimulate or halt the functioning of this centre. It appears that it is the waste products, which accumulate during the period of activity, which stimulate the sleep-inducing secretions. But it must also be remembered that we are living creatures and subject to external influences - particularly to the sequence of night and day. The effect of light on many substances manufactured in the body is very significant. In particular, light promotes secretion of the sleep hormone, which accumulates during the day, ready to go into action when we go to bed. This is one reason why night shift workers may have difficulty in sleeping and poor concentration when awake.

What happens inside the body while we are asleep?

When you are asleep, the electrical activity in the brain is quite different from when you are awake. The scientific study of sleep has been made possible by the measurement of brain waves, tiny fluctuations of electrical potential between different parts of the scalp. An electro-encephalogram (a recording made on paper of the electrical activity in the brain) can even reveal whether you are sleeping deeply or dreaming. You can see that, even when we are asleep, many things are happening in the body: the brain waves slow down: muscles relax and become limp: breathing and heartbeat become irregular; sometimes eyes move rapidly and inertness is interrupted by sudden jerks. If you wanted to fool your parents or friends into thinking you were asleep, you can see it would not be an easy thing to do and you would need to work very hard indeed to produce the right effect!

Why do babies cry so much?

Because a baby is unable to put its feelings and desires into words it communicates vocally with other people by crying. Crying in a baby is by no means only associated with unhappy experiences, such as being hungry or feeling unwell and tears do not normally appear unless the baby is really distressed.

Most mothers get to know the "vocabulary" of cries used by their baby and believe that they can tell with some accuracy what it wants from the nature of its cry. For instance, if a baby is hungry it will most likely continue to cry if picked up, but if it is crying from boredom it will stop crying when picked up or when moved to other, more interesting, surroundings.

Of course, it is not always possible to know why a baby cries. There are occasions when it is neither hungry, tired, uncomfortable, bored, frightened or wanting to be cuddled and a mother finds it impossible to quieten the baby's cries. Neither, it would seem, does the baby know what it wants and so it cries!

What is the coccyx?

The coccyx is the lower end of the spinal column of man and consists of four nodules of bone, like tiny vertebrae, corresponding to the tail, which is found in lower animals. The bones are deeply buried in muscle tissue, but occasionally they jut backwards and are surrounded by a fold of skin, so as to form an actual tail.

The name coccyx was given by the Greek physician

Galen (c.A.D. 130-200) and comes from the Greek word for "cuckoo" , as the bone rather resembles a cuckoo's bill.

Why do we have wax in our ears?

Wax is deposited in our ear by special glands to prevent dust and similar foreign material from entering.

The part of the ear that we can see as a projecting flap on the side of the head is called the auricle. Leading from it is a short tunnel, the external auditory meatus or earhole, which is closed at its inner end by a thin membrane called the ear-drum, separating it from the inner ear.

This tunnel is lined with skin which, especially in men, carries hair and sebaceous glands, that is glands which produce an oily substance called sebum. The skin also contains specialized sweat glands (ceruminous glands), which secrete the brownish yellow wax.

Sometimes the glands secrete too much wax, and then it may collect in the external auditory meatus and deaden the hearing. As the ear is such a delicate instrument, the excess wax should be removed with a syringe by a doctor, although it can sometimes be softened by the application of warmed oil.

Why do we have two eyes?

We have two eyes placed in the front of our heads because we need to be able to judge distances and to see in depth. The change in the position of the eyes from the side of the head in our remote ancestors probably came about because they needed to be able to judge distances accurately as they swung from branch to branch in the trees.

With both eyes in front, their separate fields of vision overlap. We see two images superimposed one upon the other but, because of the space between our eyes, the image from each goes a little way around its own side of the object. This is called stereoscopic vision, or vision in depth, which we share with apes and monkeys. Most other animals and fish do not have this advantage. To them the world appears flat. One exception is the owl, who sees better than any of us, and has not only stereoscopic vision, but telescopic vision, too.

Our judgement of distance depends, with near objects, upon our stereoscopic vision. As the distance increases, there is less difference between the left-eyed and the right-eyed view. So we depend upon other factors as well.

Experience tells us that the farther away an object is, the smaller it looks. Its colour also changes, its details disappear, its outline softens. Nearer objects give us a measure against which to judge the distance of farther ones. Then there is perspective, the familiar illusion that parallel lines converge towards the horizon.

What happens when we eat something very salty?

'Oh, I am thirsty! What have I eaten to make me so thirsty?' This is certainly something you will have said, if not heard. The culprit is usually very salty food: like too many crisps. What has happened to this salt? During digestion, the salt passes into the blood. If there is too much salt in the blood, the alarm is given by the organs checking the blood's composition. This alarm is transmitted to the thirst centre in the brain. Only water taken in from outside the body can dilute this excess of salt, and remove it via the kidneys. But whilst waiting for a feeling of thirst to appear, and particularly whilst waiting for it to be quenched, water is drawn from the fluid which bathes the blood cells, and some salt passes into this fluid. The water will be replaced in this fluid, shortly after a drink has been taken.

The habit of eating very salty food can cause a reaction in the body: the fluid in which the cells are bathed becomes more plentiful, the tissues 'swell', particularly those under the skin. This swelling, often noticeable in ankles and fingers, is caused by excess salt. It is neither healthy nor nice to look at. In addition, the control mechanisms which keep the salt level in the blood normal, may introduce a secretion, or hormone, which increases the blood pressure. This increase in blood pressure is called 'hypertension'. It may be slight, brief and not dangerous. Or it may become permanent and cause many health problems. This is the reason why someone with high blood pressure is put on to a salt-free diet. This may be enough to reduce the pressure, if it is caused solely by poor eating habits.

Why do we become sea-sick?

We become sea-sick because our balancing organs, the labyrinthine portions of the inner ear, are disturbed by out-of-level movements, by sudden turning movements, and by sudden changes in movements in a straight line, either horizontal or vertical.

The three semicircular canals, filled with fluid are set on different planes in the ear. When sudden movements occur, each canal is affected differently. The nerve endings have no time to convey information to the brain so giddiness is likely to occur.

Nowadays, seasickness comes under the general heading of motion sickness, a name invented by Sir Frederick Banting in 1939, which includes the discomfort people feel while travelling in all kinds of vehicles.

Sea-sickness may vary with individuals from slight uneasiness to complete prostration. They symptoms are pallor, cold sweating, nausea and vomiting. People who have lost their ear labyrinths because of disease do not become seasick. Others become resistant to it. We say they develop their "sea-legs", but it would appear to be an adjustment of the central nervous system rather than the organs of balance. Some people find it helpful to keep their gaze firmly fixed on a steady object.

Why do we have a brain?

The brain directs and coordinates movements and reflexes, registers sensations and is the supreme nervous organ by which man acquires knowledge and the power to use and adapt it. It shapes our personalities, and without it we would be more helpless than the tiniest human baby.

There are three main parts of the brain: the forebrain (or cerebrum), the midbrain and the hindbrain. They have the consistency of soft jelly and are protected by three membranes (meninges), a tough outer envelope called the dura and a watery fluid (cerebrospinal fluid) which acts as a support and a cushion. The brain is connected to the spinal cord, and its surface is highly convoluted.

The cerebrum, which forms nearly nine-tenths of the brain, is divided into two halves (hemispheres). Generally the left half of the cerebrum controls the right half of the body, and the right half of the cerebrum controls the left half of the body. Some areas are connected with the special senses of man, but there are so-called "silent areas" which scientists believe are connected with memory and the association of ideas. The thalamus, a mass of grey matter which is buried in the cerebrum, is the source of instinctive feeling and emotion.

The midbrain is concerned with eye-movements, while the hindbrain contains the nerve cells responsible for breathing, heart action, digestive juices and so on. The cerebellum, a part of the hindbrain, plays an important role in the execution of the more highly skilled movements.

What happens when we are thirsty?

Thirst is caused by the body's need for water. The mouth feels dry, and drinking is a natural response. However, the sight of pleasant drinks may lead us to drink when we are not actually thirsty. Water swallowed when there is no need for it will be digested and the blood will then contain too much water. The nerve centres responsible for monitoring the blood's composition will then alert the control systems. In this particular case, the adjustment is made in the kidneys. The kidneys will extract the excess water. This water is then emptied into the bladder, and we will soon feel a natural urge to urinate.

A high temperature during influenza can cause a thirst and dehydration (excessive fluid loss). Then it is necessary to drink more than one's thirst requires, in order to get rid of the toxins (poisons) which have accumulated in the blood.

When we do not drink enough the urine is yellower and more concentrated with 'body poisons' than when we drink sufficient. The kidneys are precious organs and it is necessary to look after them and avoid unnecessary strain.

Why do we get indigestion?

Indigestion is most often brought about by interference with a marvellous piece of engineering contained in 30 to 32 feet of continuous hollow tubing called the alimentary canal.

In this system the food is broken down, churned, diluted, dissolved and chemically split into simpler compounds which can be absorbed into the blood.

The alimentary canal is formed of membrane which has to resist a chemistry that dissolves bone, gristle, animal and vegetable matter far tougher than the membrane itself. The stomach's gastric juice, one of the chief agents in digestion, has a high concentration of hydro-chloric acid. This can dissolve a hard-boiled egg in a few minutes.

Why does it not dissolve the stomach? One reason seems to be that the stomach secretes not only acid but also ammonia, an equally powerful alkali which acts as a neutralizing agent.

The powerful gastric juice can be hindered by many causes, with the result that we may get the pains we know as indigestion.

The alimentary canal makes its preparations for a meal well in advance. The sight and smell and even the thought of food set the salivary and gastric juices flowing, while the stomach blushes in anticipation as the glands begin working and the capillaries widen to bring in an extra blood supply for the activity of digestion.

But the prospect of an unappetizing meal or disagreeable company, and the emotions of worry, irritation, anger and fear may stop these preparations. They may even cause the stomach to turn pale. Indigestion is the result.

We may also get indigestion if we eat too quickly without chewing our food or eat too many foods which are difficult to digest, thus overloading and disrupting the system.

Why does hair grow when a person dies?

Hair goes on growing after a person dies because the cells of the body go on working until they have exhausted their fuel supply.

Human cells have been described as power plants, chemicals laboratories, furnaces and factories. They are marvellous structures, which carry out the functions for which they have been designed with great efficiency.

The hair follicle is composed of two layers - an outer layer of cells forming the outer root sheath and an inner horny layer of horny, fibrous oblong cells. The hair grows upwards from the bottom of the follicle by multiplication of the soft cells, which become elongated and pigmented to form the fibre-like substance of the hair shaft.

The soft cells at the base of the follicle need the nourishment brought to them and all the other cells of the body by the bloodstream.

What is St Vitus's dance?

St Vitus's Dance is a name given to the disease chorea. It is a convulsive disease of the nerves usually associated with rheumatic fever. When someone gets chorea, the muscles - particularly of their hands, feet and face - move irregularly and involuntarily.

The name St Vitus's Dance dates from the late Middle Ages, when hysterical dancing (similar to the dancing of dervishes and voodoo cultists) was very popular. People in the grip of this hysteria often went to the chapels of St Vitus, who was believed to have great healing powers.

Chorea is chiefly a disease of childhood, occurring most often between the ages of five and 15. It is more common in girls than in boys. Sometimes the disease is mild. Sometimes it completely incapacitates the sufferer. It is quite usual for someone with the disease to be unable to hold objects or to write properly, and to have difficulty in walking. Recovery is hastened by rest in bed in a sympathetic environment.

Facial grimaces and tics are frequently confused with chorea, but these repetitive movements are quite different from the uncoordinated, purposeless movements of the disease.

What effect does the desert air have on us?

People crossing the desert have come across the pathetic corpses of animals, completely dried up. It looks as though all the water has been pumped out of the poor carcass. But this has been caused by nothing other than the drying air of these desolate regions. Have you ever wondered about the thirst of travellers lost in desert regions? It is not simply the idea of being without water in this inhospitable environment which increases their desire to drink. The dry air evaporates the least drop of water appearing on the surface of the skin. In this situation, the body constantly draws on its reserves to compensate for this startling loss. The blood becomes more concentrated, and the thirst is appalling. In the desert, a human being requires between 10 and 25 litres of water per day. This illustrates the extent to which the desert air is greedy for water.

Why does our stomach rumble sometimes?

Sometimes it is very embarrassing: you are in a quiet place and suddenly your stomach makes strange loud rumbling noises. The worse is, there is nothing you can do about it. Imagine the anguish of someone in hiding, given away by his stomach! That never happens in adventure films! We are led to believe that cinema heroes have stationary intestines which are always full; unless, of course, they know how to control them! Actually it is the movements of the intestine which are responsible for the noise.

The muscles in the intestinal walls contract and relax rhythmically to propel the food pulp from the stomach. The muscles are arranged in two ways; some in a ring and some lengthwise. The contractions of the ring-shaped muscles form constrictions, which push the food forward. The contractions of the lengthwise muscles help sections of the intestine to ripple and bend. These movements are controlled by the autonomic nervous system, which ensures the automatic operation of all organs.

In addition, the intestines have a certain control over their movements independent of the autonomic nervous system: for example, when a small section of intestine is detached and placed in a nutritive, oxygenated solution, it continues to ripple and contract. There is, therefore, a continuous motion in the abdomen.

The noises are generally inaudible, but they may become louder when the food pulp is in short supply or when it is in a fairly liquid state. There is no doubt that these 'rumblings' are most often heard when we are hungry. Since the intestines do not obey instructions from us, there is nothing we can do about them.

Why do we smile?

We smile to show our pleasure or amusement in something or with someone. In fact, smiling seems to be an expression with which we are born, for most babies smile during the first weeks of life.

Charles Darwin (1809-1882), the great English naturalist who established the theory of organic evolution in his work, *Origin of Species*, also published, in 1872, a book, *Expression of the Emotions in Man and Animals,* in which he studied the facial expressions of men and animals. Most of the experiments connected with facial expression have been based on this book.

It has been suggested that a baby begins to realize within its first year of life that a smile is a "good" expression because it is greeted with pleasure by mother or nurse. The smile develops, some time after the twentieth week of life, into laughter but there are great differences between the frequency of laughter and smiles in individuals.

As the child grows up, the action of smiling becomes bound up with a growing awareness of what is socially acceptable in certain situations. In an adult it is often difficult to be certain whether the response is truly emotional or not. Recently different kinds of smiles have been more closely observed. It is notable that the pattern of the smile alters, according to the situation, from a wide spontaneous grin akin to laughter to a tight, nervous grimace which is nearer to a reaction of fear.

Why is cod-liver oil, which tastes so nasty, so good for us?

Not so long ago, parents used to place a small glass beside their children's plate. This contained a liquid which tasted as horrible as it smelled. How many generations of children have suffered from this oil extracted from cod's liver! Even adults considered it particularly loathsome and nauseating. And yet it is one of Nature's ways of caring for us. Cod-liver oil contains, in large quantities, two vitamins which are essential to life.

Vitamins are substances with very important functions. They help our body to make use of substances which it cannot do without, and which can only be assimilated with their help. They help to transform inert secretion into active secretions. Although they are effective in very low doses, they have to be present regularly in our food, because they are delicate and quickly destroyed.

Cod-liver oil contains vitamins A and D. Vitamin A promotes growth, helps wounds to heal, strengthens our defences against germs, helps in manufacturing healthy hormones for reproduction and assists in the renewal of the red pigment found in the rods of the retina. (The rods are sensitive to light changes.) Vitamin D helps the body to assimilate the calcium necessary for healthy bones. A lack of vitamin D causes rickets: the skeleton develops badly, the bones are brittle, soft and deformed.

This is what may happen to a person who does not take vitamin A: loss of night vision, lesions of the eyes which can turn into a mass of pus, poor growth and all sorts of germs easily caught ... Frightening isn't it? Now you understand why the 'cod-liver oil treatment' has been inflicted on so many children. If you have never taken any, you may become alarmed. Do not worry: vitamin A and D are not found only in cod-liver oil. They are also found in butter, milk, egg yolk - and in certain pharmaceutical preparations. Besides, now you can take a course of fish oil without being upset by the taste and smell. Nowadays, the fish oil is inclosed in capsules, which do not open up until they reach the intestine.

Where is the aorta?

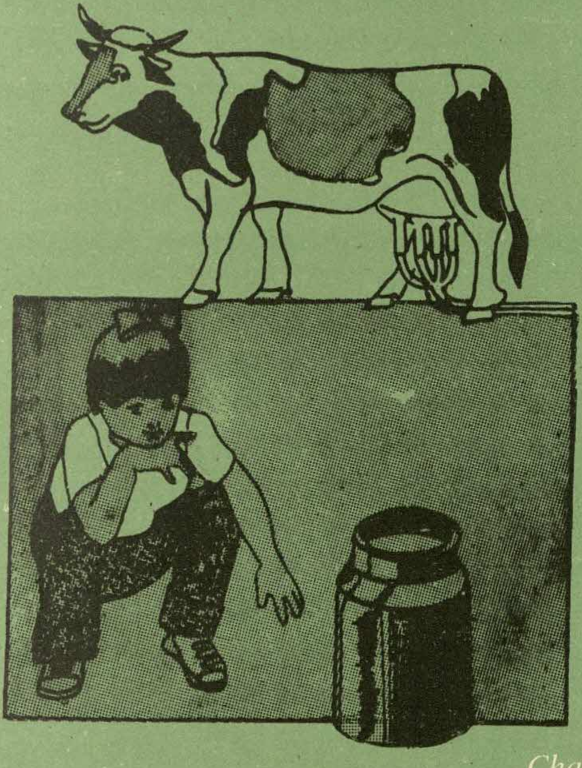
The aorta is the great artery rising from the left side of the heart, through which the blood passes on its way to all parts of the body except the lungs, which are supplied by another system.

After rising from the heart, the aorta forms an arch, descending down the left side of the body. It passes through the diaphragm into the abdomen, where it divides into two lesser arteries. One of these terminates under the end of the backbone, where man has the vestige of a tail. In animals it continues into the tail as the caudal artery.

The aorta is one of the elastic - or conducting arteries, which take the blood to the muscular - or distributing - ones, which connect with the veins and smaller blood vessels.

Three valves at the exit of the aorta protect the heart from any back pressure that might develop in the artery and force the blood in the wrong direction.

Inflammation caused by an illness such as rheumatic fever may sometimes cause these valves to leak. This is a serious condition requiring considerable medical care and attention. But in normal cases your aorta will continue to function reliably throughout your life.



Chapter 3

General Knowledge

Where are fish caught?

From the edge of the seashore, the land continues to slope away underwater making a gently tilted ledge. In some places, this ledge continues to slope out to sea for many kilometres. It is called the Continental Shelf.

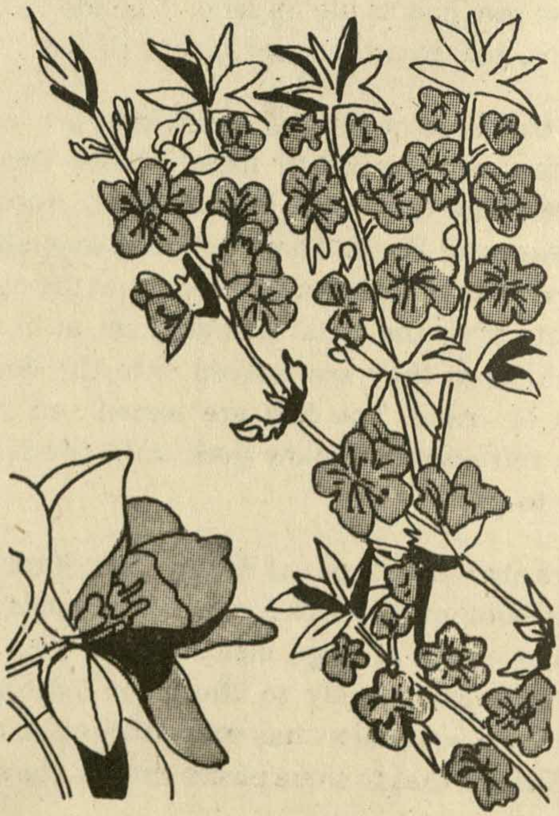
The water above the Continental Shelf can be 200 metres deep. Sunlight filters through to the bed of the shelf bringing both light and warmth. Since life in the sea, just as life on land, depends on these conditions, sea creatures and plants thrive.

Most of the large quantities of fish that are caught for our food are trapped by fishing boats. Trawlers are large boats that work in the deeper waters of the Continental Shelf. Their nets are cone shaped and are sometimes thirty metres across at the mouth. The boats drag the nets behind them until filled with fish, then they are heaved onto the deck by a winch or crane. The fish are sorted and stored in huge refrigerators below deck until the trawler returns to port.

Trawlers and other types of fishing boat often carry electrical equipment which picks up the sounds made by the movement of large shoals of fish. This helps fishermen move quickly to the right location. In fact, modern equipment has made fishing so much more efficient, that in some places close to the shore, not enough fish are managing to breed. Fishermen find they must travel further and further out to sea for their catch, and this has led to new kinds of deep sea fish arriving on our plates.

Why do flowers grow on trees?

The flower is the part of a plant which produces seeds. These seeds then produce more plants. So the flower is the reproductive part of the plant.



In the case of trees, the flower (or blossom) grows into fruit or berries. It is the fruit or berries which hold the seeds. If you cut open a fruit or berry, you will see the seeds inside.

Some trees have flowers which are hardly noticeable as they are very small or are the same colour as the leaves. Other trees have very obvious and beautiful blossom, such as the almond tree. However, with the almond tree, the fruit is the nut and the inner part of the almond, the kernel (which is the part we eat) is the seed.

How our Solar System Works?

Each planet has its own orbit or path round the sun. Every planet moves round the Sun from west to east.

The planets cannot drift away from the Sun. They are held in their orbits by the Sun's gravity. The orbits of the planets are not quite circular. They are shaped like squashed circles. This shape is called an ellipse.

Planets are moving round the Sun all the time. As they go round their orbit, we can see them in different parts of the sky.

The time a planet takes to go round its orbit is called its year. Our year lasts 365 days. There are two planets closer to the Sun. They go round in less time. There are six planets farther from the Sun. They have much longer years than ours.

The average distance of the Earth from the Sun is 150 million kilometres. Its nearest distance is 147 kilometres. At its farthest, the Earth is about 153 million kilometres from the Sun.

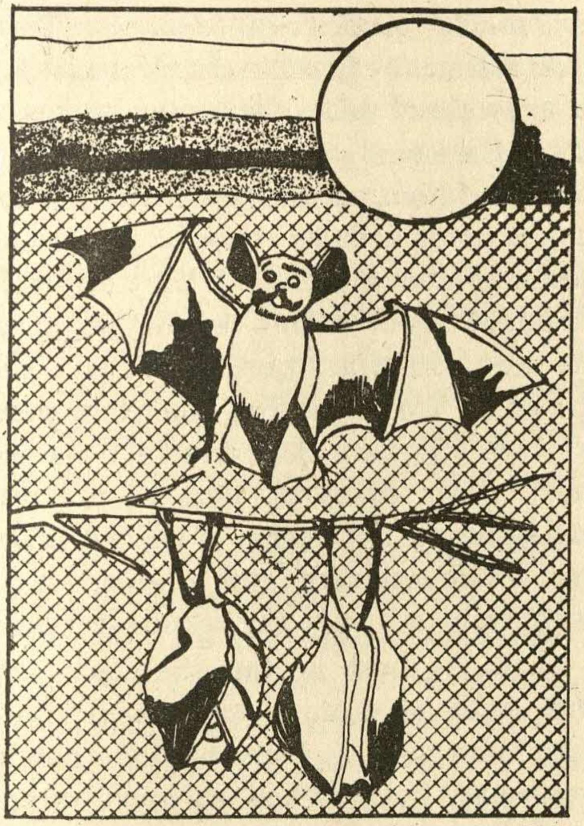
Planets do not only go round the Sun. They have another movement. Each planet spins on its own axis. The axis is an imaginary line that runs from the north to the south pole. Each planet is like a spinning top.

The Earth spins once in 24 hours. This is its 'day'. Other planets spin at different speeds. Some are much slower spinners. Not all of them spin the same way. The Earth turns from west to east. At least one planet goes the other way.

Why are people scared of bats?

These winged mammals, who sleep during the day and are active at night, have always had the reputation for being evil, even though most of them are really quite harmless.

But there is one American variety which does drink blood and attacks animals and men. This bat has well-developed incisor teeth which it uses to puncture



the skin of the victim, and then it licks the blood which flows from the wound. The victim does not feel this.

Natives of South America, who are used to sleeping out in the open, have to wrap themselves up in their ponchos to protect themselves against attacks by these bats.

What is the theory of the atom?

According to atomic theory, each molecule is divided into even smaller particles called atoms. (The word 'atom' comes from the Greek and means 'indivisible'.) Thus a molecule of salt contains two atoms, and a molecule of limestone contain five atoms. There are several kinds of atom, and they in turn are subdivided. The subject raises a whole series of questions. How many kinds of atom are there in the universe? How are they linked together? How can they be separated? And the most important question of all - can the atom be split? We know that the atom has been divided: once scientists discovered it was possible in theory their research had to continue. A tremendous amount of energy is needed to split an atom, and whether this energy is to be used creatively or destructively is a very important decision.

All we shall say here is that there are about a hundred kinds of atom, which form the basic elements. Some we meet every day, like those which make up water (H_2O); others are much rarer, such as gold. Others are dangerous or poisonous, such as mercury, and others again are radioactive - a problem which many people are concerned about today.

Some of these elements are found in the pure state, such as mercury, gold, silver and other metals, and also sulphur, which is not a metal. Most are found in nature linked to other elements, and this is where molecules come in. A molecule of pure salt contains only two atoms, but most salt molecules are much more complex. There is one chemical law which never alters, however - all the molecules in the particular substance contain the same number of atoms. Thus a molecule of limestone will always consist of one calcium atom, one carbon atom and three oxygen atoms.

There are stable relationships between atoms, and unstable ones. Various chemical processes are used to make these links and to undo them. For example, strong acids acting on some substances can dissolve certain unstable links to form others. Sulphuric, hydrochloric and nitric acids are used in this way.

The atomic theory also explains some of the properties of solids, liquids and gases. In a solid each molecule has a fixed position - it cannot change its place, only vibrate slightly. In liquids the molecules can move around, so the liquid can change its shape. In gases the molecules are much further apart: most gases will fill whatever container they are put in.

The alchemists were really the forerunners of modern chemists. However strange some of their practices may seem today, their discoveries have still found an application in present-day chemistry.

Why do some people use a white stick?

Not long ago, every gentleman carried a walking

stick, and around the turn of the century no 'elegant' man would be seen without one. There was even a different stick for each part of the day. Nowadays, they are not generally used except by blind people and those who cannot walk very well. A blind person's stick is white, and only those with poor sight are allowed to use one. It is partly for feeling the way, and partly so that people will recognise that the owner is blind, and will help them.

Why do we call the Fire Brigade?

It may be possible for adults to extinguish a fire which has just started. It can be covered with a thick blanket or rug. It can be squirted with special foam from an extinguisher. It can be buried under earth or sand, or drowned with water. But when a fire spreads and gets out of control, the fire brigade must be called immediately. When you dial the emergency code, you are connected to the fire operator who takes down details about the fire. Where is it? What has caused it? The operator decides the quickest route and how many engines to send. Within minutes, the first engine is on its way. The instructions are phoned to the nearest fire station.

What is the difference between the memory of a human being and the memory of an animal?

The dog which does tricks for a master who returns home after a long absence is not actually proving that he has a memory. That is to say, not a memory as we understand it in human terms. For the dog, the master's arrival produces a series of pleasant images in his brain: food, stroking, games, a walk. These images trigger a sense of well-being, play-fulness.

If an animal appears to be sad when the person who cares for him is away, it is because absence means discomfort: no reassuring smells or friendly voices. He feels worse than when his owner is there. When the owner is there, he will behave in a contented manner.

Animals do not have a true memory. Depending upon their brain capacity, they have the ability to learn, to associate images and to feel, in varying degrees. But they are not able to conjure up these images in the brain without external stimulation.

What makes us sneeze?

A sneeze occurs when the white tissue or lining in our nose - called a membrane - gets inflamed or irritated. Our body reacts by letting out air as quickly as possible through the nose and mouth in an attempt to get rid of whatever is causing the irritation.

People used to make themselves sneeze by putting snuff, a kind of finely-ground tobacco, into their nostrils. This would tickle the membrane in the nose. Sneezing was thought to be healthy because it helped to get rid of germs.

Why does lemonade fizz?

Whether we call it soda, pop, or lemonade, fizzy drinks are a mixture of water, sugar, salt, flavourings, and a special kind of air called *carbon dioxide*. The fizz we see is tiny bubbles of carbon dioxide. When a bottle is opened, all the bubbles rush to the top. We see all the bubbles as fizz. Sometimes those little bubbles can even pop up and tickle our nose!

Where are tears made?

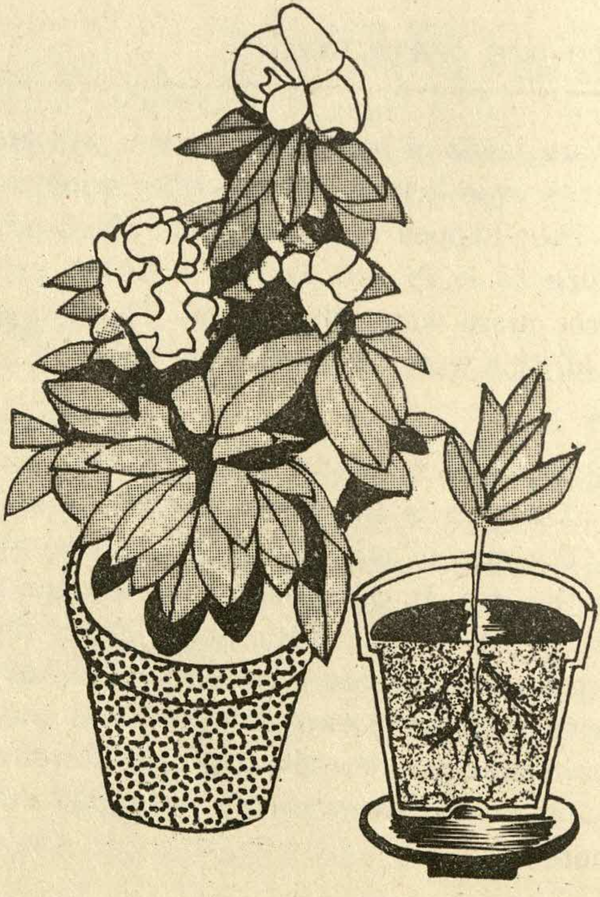
Tears are made of salt water, as you will know if you have ever licked a finger after wiping them away. They happen when the gland which provides moisture to keep the eyeball rotating properly produces more water than usual. The eye cannot drain all this water as it does normally, so a flood occurs.

The gland which makes tears is called the lachrymal gland (*Lacryma* is the Latin word for tear). It is about the size of an almond nut and is situated above the eye. It opens on to the surface of the eyeball by six or more little ducts. Every time we blink the water is spread over the eye. Any extra water is collected in two little canals at the inner corner of the eye where the upper and lower eyelids join, and carried away to the lachrymal sac near the nose.

The tear gland makes more water than usual when stimulated by a really pungent smell, like onions, or household ammonia, or by a situation of great emotional stress, be it happy or sad.

Why is there a hole in the bottom of a flower pot?

Plants in the house give people a lot of pleasure,



especially if there is no garden. But house plants do require a lot of care. The reason they are planted in pots with a hole in the bottom is to allow water to drain through. If there is too much water in the pot, the plant becomes waterlogged. Plants can die from having too much water just as they can die from lack of water.

The hole at the bottom of the pot also allows air to circulate. If there were no air in the earth, the plants might suffocate. A layer of pebbles in the bottom of the pot also helps to drain and aerate the plant. When roots appear through the hole, the plant needs repotting.

What makes a river wind?

A river always takes the easiest course through channels and soft ground to the sea, flowing swiftly down mountain sides but much more slowly on the level plains.

On the plain the river takes advantage of every difference in gradient. This winding course is accentuated by the process of silting and erosion. As a river flows round a curve, the water on the outer bend moves more swiftly to cover the greater distance in the same time as the water flowing past the inner bend.

The more rapidly moving water will tend to wear away the banks of the channel, while the slower movement of the water on the inside wall will allow silting to take place. When the curve becomes more pronounced it is known as a "meanders". Notable examples of meanders are to be found in the Wye in England, and the Meuse in France.

Sometimes the river erodes the bank so fiercely that a new channel is formed, leaving an island of earth in the middle of the stream.

Why do some flowers close up at night?

Some flowers are very delicate and are sensitive to changes in temperature and light. So at dusk, when it gets cooler and the light begins to fade, these flowers close up their petals, as if they were going to sleep. It is not absolutely certain if it is lack of light, or the drop in temperature, which causes this closing of the petals, or a combination of both. Sometimes, when it becomes very hot during the day, the flowers close their petals to protect themselves from the heat.

How the solar system was made?

The planets were born a very long time ago. Astronomers think that they are thousands of millions of years old. It is hard to tell what happened when they were formed. But astronomers think that the planets were made from stuff left over from the Sun.

A cloud of gas and dust made the Sun. Not all the dust and gas went into the Sun. Some of it began to go round the Sun. It was spread out into a flat disc.

Inside the disc, specks of matter began to run into each other. They stuck together. Slowly, bigger and bigger balls were formed. These became the planets.

What is a Lodgepole?

An Eastern Chipmunk found in the woodlands of the eastern United States and Canada. These cheeky little creatures like trees, unlike other members of the chipmunk family who prefer the ground. They eat fruit and berries, often storing food in their cheeks until it is safe to eat it if they are pursued by predators. They live in underground burrows made up of a network of tunnels and passages.

Why is it unhealthy to smoke?

The smoking habit came to Europe in the sixteenth century when tobacco was brought back from the United States. Smoking is a habit on which people

easily become dependent, and it causes great damage to the human body. Tobacco contains a very toxic substance called nicotine, which is very bad for the respiratory (breathing) system, the heart, and the blood.

What was the Legend of Popocatepetl?

Two high peaks tower above the other mountains of Mexico. The mountains, Ixtaccihuatl, is covered with snow and is very beautiful. The other is a snow-capped volcano, Popocatepetl. It is not an explosive volcano, but it does pour out a continuous cloud of smoke.

The Mexicans tell a story about their smoking mountains. They believe that Ixtaccihuatl was a beautiful princess, daughter of a powerful Mexican king who had many enemies. The king promised that his daughter would marry the man who defeated his enemies. Popocatepetl loved the princess and he set off to fight for her hand.

Popocatepetl finally defeated all the king's enemies and started triumphantly for home to claim his bride. But before he reached the palace, jealous enemies sent false news of his death to the princess. She was so upset that she became ill and died.

When Popocatepetl arrived home and discovered that she was dead, he too wanted to die. He built two great pyramids next to each other. He laid the body of Ixtaccihuatl on top of one pyramid and he stood on top of the other, lighting her tomb with a flaming torch.

As the years passed, snow covered the pyramids and the lovers, but the torch continues to smoke to this day.

What are molecules?

One of the most important discoveries made in chemistry was that all matter is made up of minute

particles - originally they were thought to be the smallest - which are called molecules. Now we can define molecules as the smallest particle of any substance that retains the properties of that substance.
If one takes a jar of kitchen salt, for example, we know that it contains an infinite number of molecules of salt which are all the same size and have the same properties.

When no other molecules are mixed with them, we can talk of 'pure salt'. Over the course of time, however, it was discovered that it is impossible to obtain a substance which is totally pure.

In a number of special cases, impurities play a vital part in creating the properties for which a substance is valued. It was chiefly in analyzing chemical fertilizers that it was discovered to what extent small impurities could be important.

Once molecules were known to exist, people wondered whether chemical substances might not contain even smaller particles which made up the atoms. And this was how the theory of the atom was born.

Why are lions and eagles painted on shields?

Throughout history, kings, princes, knights and noble lords have used a picture of a lion as a symbol of courage and high birth. They painted or engraved lions on their shields, flags and cloaks.

The Black Prince, a royal English knight, fixed a lion crest to his helmet. Another brave royal soldier, Richard I of England, became known as Richard the Lionheart. His shield and crest were decorated with three lions. He was a fierce, fearless fighter.

The lion is often seen as a 'supporter', holding up one or both sides of a shield. The Royal Arms, which is the emblem of the British Royal family, is supported by a lion and a unicorn.

For thousands of years conquering armies have followed an eagle flag, or standard, believing it would lead them to victory. In the first century A.D., the Romans tried to conquer the world. Each legion, or section of the Roman army, marched behind a standard on top of which was an eagle.

Many other kings and army leaders have since adopted the eagle as their symbol. Eagle banners were carried by knights to the Crusades. In the early nineteenth century Napoleon made the eagle the symbol of France.

In 1782 the Bald Eagle was adopted as the national emblem of the United States of America. The emblem, which is called the Great Seal, shows an eagle holding an olive branch, the symbol of peace, in its right talons and in its left talons are a bundle of arrows, the symbol of military power.

Why do we blink?

It is impossible to go for a long period without blinking. The eyes, and particularly the conjunctiva (mucous membrane covering the eyeball and lining the eyelids) and the cornea (transparent surface of the eyeball) need to be kept clean and moist.

Animals, such as fish, which live permanently in water, do not need to blink. The same applies to snakes, which have a transparent eyelid permanently in front of the eye. They do not need to blink because their eyes are already protected from drying out by this eyelid.

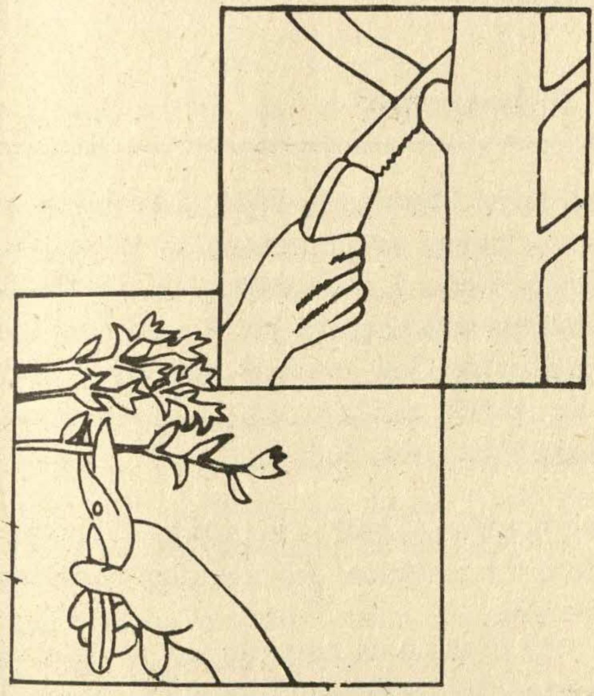
When our eyes feel dry, we blink. If we do not do so, the body reacts by activating the glands which produce tears and we 'cry'.

People who wear contact lenses to improve their sight, learn to keep their eyes and lenses moist by blinking the eyelids more vigorously. (This quickly becomes a habit.)

The conjunctiva, the thin, transparent skin which covers the eyes, is very delicate. It has scarcely any protection against the air or dust, but blinking helps to lubricate the eye with tears.

Why do people cut off branches of trees?

Cutting some of the branches off trees and bushes is called pruning. One reason for pruning is to remove dead or diseased wood. This keeps the tree healthy and encourages growth. In the case of a fruit tree, pruning helps to produce larger fruit as the nutrients are not wasted in feeding unnecessary branches. People also prune rose bushes in order to grow larger flowers. Ornamental trees and bushes are pruned to give them a more attractive shape.



Why does popcorn pop?

Popcorn is made from dried kernels of corn. When we heat it, tiny drops of water inside the kernels turn into steam. The steam wants to escape, but it can't, and the only way for it to get out is to break open the kernel. When the kernel pops we have popcorn!

What is hair for?

Hair has several functions. First, it keeps us warm. This is no longer as important as it was in the days of our Stone Age ancestors, who were worse off for clothes and heating, but a good deal hairier. There are, in fact, few areas of the body - the palms of the hands and the soles of the feet - which are not covered with fine hair.

A second function of hair is to protect delicate parts. Eyelashes, for instance, prevent dust entering the sensitive eye.

In the case of animals hair can act as camouflage. By matching the background, an animal's coat helps it to avoid enemies. The northern hare even grows a white coat in winter as camouflage in the snow.

The hair of both animals and human being also serves to attract mates. People wear wigs and go to hairdressers to make themselves attractive to others.

But unlike many animals, we have no special sensory hairs helping us to feel our way around. A cat's whiskers are as sensitive as radio aerials. Being wider than the widest part of its body, they also help it tell whether it can get through a narrow space, even when it is dark.

Why does India have monsoons?

The seasonal winds of south-west Asia known as monsoons are associated particularly with India because of the tremendous effects they have on the lives of the inhabitants. The winds are drawn to India by changes in the temperature of the great land mass. A good monsoon season with plenty of rain means a comparatively good supply of food. A bad monsoon with little rain means a bad rice crop and, perhaps, starvation for many millions.

Monsoon comes from the Arabic *mausim*, meaning season. The summer season monsoon is a great inrush of moisture-laden air from the ocean. The winter monsoon blows from the land to the sea.

In India there are three seasons: the hot dry season from March to June; the hot wet season from June to November; and the cool dry season from December to March. During the hot dry season the great plains of northern India become like a furnace and a region of low pressure develops.

By mid-June, the pressure is low all the way to the Equator and draws the south-east trade winds to India, filled with water-vapour as they cross the Indian Ocean. When they meet the hot dry air over India, violent thunderstorms result, followed by steady rain in July. By November India has received three-quarters of its annual rainfall.

Then the land mass cools and the high pressure attracts the north east trade winds. These bring no rain to India except to the Coromandel Coast and Ceylon, where the rainfall in late September is heavy, because the winds have picked up water vapour as they move across the wide expanse of the Bay of Bengal.

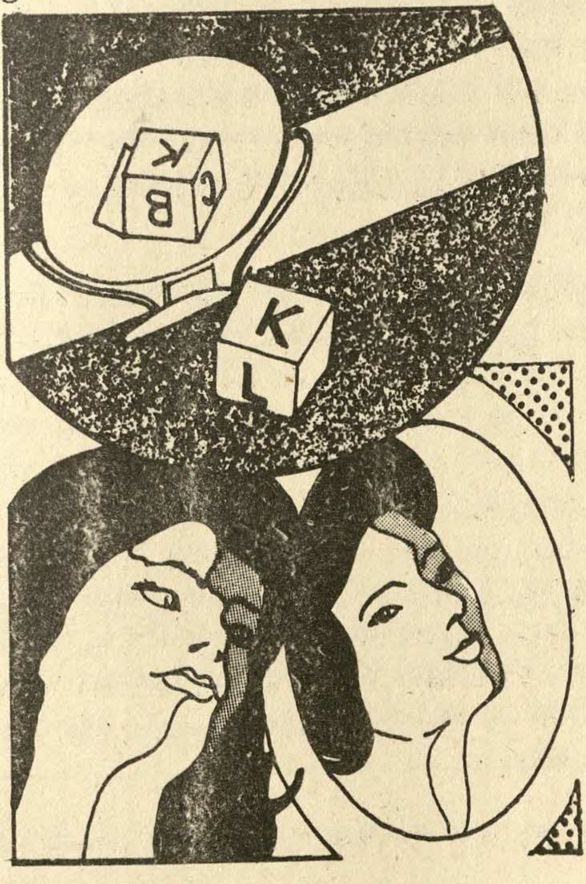
How old is the Universe?

We can try to work out when the Universe must have formed. What we do is to trace the bits backwards. We find out when they were close together.

Astronomers think the Universe is between 10 and 20 thousand million years old. At some time all those years ago, the big bang explosion might have happened. We cannot work out the exact time when it happened.

Why do we see a reflection in a mirror?

Mirrors are made of polished metal, or glass which is coated on the back with a metal film such as silver or tin. These surfaces can reflect light almost completely, without changing it. When we stand in front of a mirror, the light rays reflected by the body reach the surface of the mirror and are reflected back again towards us.



As it is a reflected image, it seems to be the other way round. Consequently, if the right hand is moved in front of the mirror, it looks as if the reflected image is moving its left hand. And if some writing is held up to the mirror, it is reflected back to front, making it difficult to read.

What is your fortune?

The gypsy fortune-teller gazes deeply into a crystal ball in front of her. She seems to see moving pictures, shapes and words hidden in the glass. Slowly, she explain their mysterious meanings. She recalls things that happened long ago to her customer, and foretells events to come.

The palms of your hands are criss-crossed with lines and the gypsy fortune-teller may try to predict your future by looking at them. Everybody has different patterns on their palms and fingers but very few hands have all the lines shown. If you are right-handed the palmist reads your right hand to see what you will make of your life, while your left hand shows the possibilities with which you were born. If you are left-handed it is exactly the reverse. Palmistry is a very ancient art which was practised in the Far East at least five thousand years ago.

All cards can be used for fortune-telling, but sometimes a special pack called the Tarot is used. Tarot cards are supposed to be especially magical and their origin is ancient and mysterious.

There are many ways of using a Tarot pack. One of them is to tell the future by using the Clock, or Circle, spread method. 12 cards are laid down in a circle and a 13th is placed in the middle. Card 13 is read first as a forecast for the whole year; then the others are read one by one. If the cards are laid upside down their meanings change.

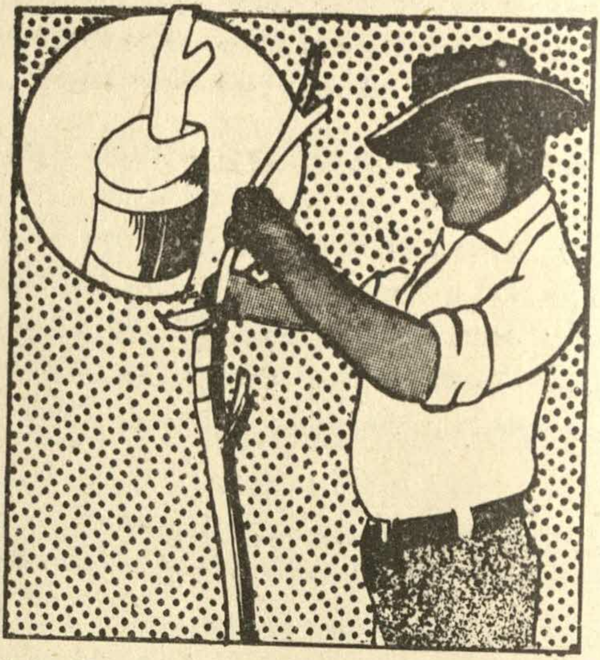
What is studied in chemistry?

Chemistry is the study of the composition of all the materials which are found on the Earth. It explains which elements go to make them up, how they are related to one another, and how their composition and properties can be changed to turn them into materials for use by industry or commercial products.

Theoretical chemists seldom concern themselves what practical use their discoveries could have, but they seldom object if other people make use of them.

Why do we graft trees?

Some trees produce a large quantity of excellent



fruits, but the tree itself may not be very strong. In this case, a branch from the fruit tree can be grafted onto the trunk of another, stronger tree. This is done by placing the branch in a prepared split in the trunk of the stronger tree. In time, the branch will grow and produce other branches, and eventually fruit. This way, the best qualities of both trees are combined. Grafting is also done to reproduce trees that have become rare or diseased.

How does the Fire Brigade fight a fire?

The correct name for a modern fire engine is an appliance. Various appliances are designed to carry different fire-fighting equipment. The appliance that races past your house to a fire nearby is probably a pump-escape or a pump.

Both appliances carry large tanks of water, with several taps on them. Each tap pumps water down a different hosepipe which is wound onto a large reel. On the tip of each hosepipe is a nozzle which controls the force of the water sending out a fine spray, or a fierce jet, depending on the size of the fire.

The Turntable Ladder reaches up to the top of high buildings. People climb down the ladder to escape the fire.

The Emergency Tender carries extra equipment such as oxygen breathing apparatus. At night it lights up the scene of the fire with searchlights.

Firemen throw ropes with hooks up to windows to grip the balconies and window ledges. Trapped people slide down the ropes to safety. Firemen lower injured people to the ground on stretchers. Special flame cutters melt through steel doors and bars to rescue anyone caught inside.

Fires in buildings along river banks or in seaports may be tackled by fireboats.

Why must we be careful when going into cold water?

If you plunge a glass into very hot water and then into cold water, there is a very good chance that it will crack. Yet someone who takes great care with his glassware, does not hesitate to dive straight into cold water after sun-bathing for half an hour, or even longer. This really lacks common sense!

The human body is remarkably well-equipped to adapt to very varied temperatures, but we have to give it time to do so.

The body needs to maintain an internal temperature of 37°C (98.4°F). If you are very hot - for example, you have been sitting or lying in the sun for a long time - the body triggers off systems to fight this excess of heat. These cause perspiration and dilation of the blood vessels running beneath the skin. If you then wish to dive into the water to refresh yourself, you must not do it too suddenly. This is because in the water, your body will no longer be fighting the heat, but the cold. To avoid cooling down, the circulation will speed up and the diameter of the blood vessels under the skin decrease.

This reversal of the body's air-conditioning system cannot be carried out suddenly without shocks occurring. These can be dangerous. *Hydrocution* (a sudden failure of blood supply to the brain due to immersion in water) is the worst which can happen, and often, unfortunately, results in death.

You must, therefore, be sensible about going suddenly into cold water. Take the following precaution: when the water comes up to your ankles, moisten the nape of your neck and your abdomen and kidneys by splashing water on your body. If you feel the slightest discomfort, dizziness, pains in the chest or a lump in the throat, the wise thing is to get out of the water. Sit in the shade until you have calmed down, and be prepared to postpone your swim until the next day.

If you dive straight into the water, you will not feel the above warning signals which tell you that the body's defence mechanism against the cold is not working properly.

Ignore people who, when you go into the water slowly, treat you like a baby. They are the foolish ones.

You are not made of glass, it is true. But it is still necessary to look after your body, to protect it from unnecessary stress and to be aware of what it can and cannot do.

Why do we vaccinate against smallpox?

We vaccinate against smallpox to allow the body to develop antibodies which will make it more or less immune to attack from the disease. In fact, by vaccination or inoculation we mean that a person is injected with the organism that causes the disease or its toxin (poison). This organism is modified physically or chemically, so that, without doing any damage, it triggers the body's immunizing defences. We call these modified cultures vaccines.

Vaccination against smallpox was first carried out in the East. Poisonous material taken from the blisters of a mild case of smallpox was inserted into the arm of the person to be protected. This produced a mild case of smallpox and enabled the body to manufacture the antibodies.

Vaccination was introduced into England in 1721 by Lady Mary Wortley Montagu, wife of the British ambassador to Turkey, who had her own children inoculated at Constantinople. However, this method could result in a severe or fatal attack of the disease.

Dr. Edward Jenner took the next step in 1796 when he inoculated a boy named James Phipps with poisonous matter from the arm of Sarah Nelmes, a dairymaid suffering from cowpox (a mild disease closely allied to smallpox). Some weeks later he inoculated James Phipps with smallpox, but the boy did not contract the disease.

In 1798 Jenner published a book on his experiments, and the practice of vaccination spread throughout the world. The principle has been applied to many diseases. Babies and young children are particularly susceptible to complications from whooping cough and diphtheria, so they are immunized soon after birth. Poliomyelitis (infantile paralysis), cholera, yellow fever, and typhoid are all dangerous diseases which inoculation has been able to control.

Why were early maps decorated?

Many early maps were decorated because the map-makers or carto-graphers had little real idea of geography and presented the world in symbolical terms. One map of Roman times showed the world as a T within O. The O represented the Ocean boundaries of the earth and the T the known world with the Mediterranean as the upright and the horizontal bar as the meridian from the Nile to the River Don. Jerusalem was at the centre and elaborate decorations often included Paradise and the Last Judgement.

As the shapes of more coastlines were discovered, the unexplored land masses behind them were often filled by map-makers with decorative portrayals of imagined animals and vegetation. The seas contained monsters and pictures of ships.

Even when maps became more accurate, decorations survived because cartographers saw their craft as a mixture of science and art.

Some maps were specially commissioned to be given as gifts to noble patrons or sovereigns. Unlike ordinary maps for use at sea, these special productions were magnificently decorated, with the seas and lands full of fabulous animals and the winds portrayed as human. The houses and ships shown were usually accurate pictures of those in use at the time the maps were made.

How can we see ourself in a mirror?

We know that we can see through a glass window. Like windows, mirrors are made of highly polished glass. But instead of being clear, the back of a mirror is covered with a special silver coating that light cannot go through. When light hits the silver coating, it bounces back at you, and we see ourself reflected in the mirror.

Why do crickets sing?

Actually, crickets don't sing - they use their bodies

like instruments to produce the sound. Have you ever heard the happy 'chirp chirp' of crickets in the country? Male crickets make this sound when their front wings are at an angle of 45° and they rub them together. A scraper on one forewing rubs against many little 'teeth' on the other forewing, and this produces the song.

When was coffee first grown?

A legend says the coffee plant first grew in Kaffa, a province in south Ethiopia, where it was discovered by a goatherd called Kaldi about the year 850. Kaldi's goats were reported to have skipped and pranced in a strange manner after feeding on an evergreen plant. The goatherd, so the story goes, tried some of the berries himself and excitedly dashed to the nearest town to tell of his find, which was called coffee after the name of the province.

Another theory is that the word coffee is probably derived from the Arabic *qahwah*. Certainly coffee was introduced into Europe from Arabia during the 16th and 17th Centuries. The first licence to sell coffee in the United States was issued to Dorothy Jones of Boston in 1670. The coffee houses of this time became famous meeting places for discussion.

As the drinking of coffee became more popular, its production spread to Java, Haiti, Dutch Guiana, Brazil, Cuba, Jamaica, Puerto Rica, Costa Rica, Venezuela, Mexico, Colombia, the Hawaiian Islands and, in this century, Africa.

How does the Egyptian plover bird help the Nile crocodile?

By picking the morsels of food from between the crocodile's teeth and so helping to keep the teeth clean. In thus helping the crocodile, the plover bird also gets food for itself. Crocodiles will snap at the hand of a man but they allow the plover to pick out leeches and other larvae from their teeth without harming them at all. This strange friendship between these two creatures has existed for many years.

Why are young babies fed on milk?

Young babies are fed on milk because it is their natural food. The females of all backboned animals whose young are nourished with milk, store this fluid in their breasts, or mammae. The milk of each species of mammal is a complete food for its own young after birth.

Although the same ingredients are present in the milk of all mammals, the proportions differ a great deal. The ingredients are water, protein, fat and milk sugar. Milk protein contains all the essential amino-acids. The fat globules remain enclosed in a soft curd which milk forms in the stomachs of the young, so that digestion can proceed smoothly without the disturbance that fatty foods often cause.

Human babies, if not fed by their mothers, may be fed with pasteurized cow's milk, diluted and sweetened, or a liquid reconstituted from laboratory-prepared dried milk. In various countries babies have been fed on milk from the ass, goat, water-buffalo, reindeer, caribou, sheep, camel, llama, bitch and mare.

Other foods have been tried. In the 17th Century babies were fed on pap (bread cooked in water) or, as a French doctor advised, bread cooked in beer! After about four or five months human babies are gradually weaned from an exclusive diet of milk and given other forms of nourishment.

Why do desert dwellers wear such roomy clothes?

In the desert, it is scorching hot during the day and cold at night. The use of roomy clothes solves these problems.

If you have heard of energy-saving, you will know that it is possible to build houses which retain heat in the winter and stay cool in the summer. This is achieved by leaving a hallow cavity between the layers of materials which form the walls. Air is then trapped in this cavity as an excellent insulator against heat and cold.

By wearing roomy clothes, the inhabitants of desert regions achieve the same effect and utilize the insulating property of air. Their long garments provide spaces between the material and their skin, where the air can circulate. The many folds are also air traps. Excessive heat or cold is thus prevented by the material, which lies in folds and does not stick to the body. If the people perspire - and remember sweat is one way the blood cools off - the sweat can easily evaporate in the freely-circulating air. So, loose garments do not impede the blood circulation; they allow the circulatory system to work comfortably and efficiently.

Why do trees near the sea grow at an angle?

Sometimes trees which grow near the sea seem to grow at an angle and appear to lean.

This is because from the time they are young (saplings) they are blown by very strong winds from the sea. Because young trees bend easily, the strength of the wind makes them grow at a slant instead of upright. As the trees mature, the trunks harden at this angle. The trees, therefore, grow permanently slanted.

Why do people put manure on the ground?

If land is being used all the time for growing crops and vegetables, the minerals in the soil get used up and need replacing. So farmers and gardeners put fertiliser on the ground to replenish the soil with all the nutrients plants need.

There are two types of fertiliser, mineral and organic. The mineral fertilisers are manufactured and can be bought. The organic fertilisers are made of plant matter and animal dung, built up over a period of time into a manure heap. Farmers spread this manure onto the earth.

Animal dung is waste products from digested food and contains nutrients which are easily absorbed through the roots of plants. It is best to spread it over the ground when it is fresh so that none of the nutritional value is lost. Sometimes the manure is dampened so that it soaks into the ground more quickly and easily.

What is so special about a Przewalski's horse?

It is the only true remaining wild horse left living in a natural habitat. It was discovered in the late 19th century by the man whose name it bears, roaming wild and free in central Asia. It can still be found in Mongolia today in small numbers, but to make sure that the breed does not become entirely extinct it can also be seen in many zoos, and if bred successfully several may be returned to the steppes to live in a real wild state.

What the Sun does to the Earth?

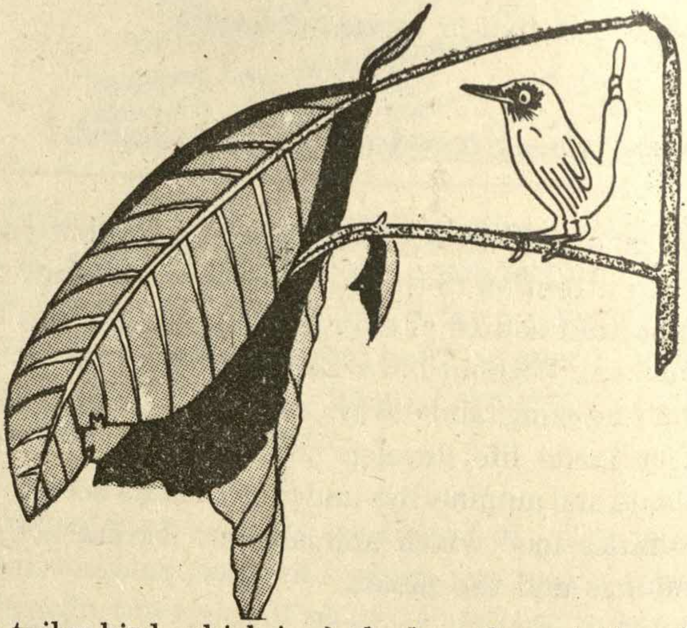
We go about our everyday business without paying much attention to the Sun. But the Sun is our most important source of energy. The Sun gives us light and heat. Without it the Earth would be much colder than freezing, and always dark. The Sun's light and heat made life develop on earth. The Sun helps plants and animals live and grow. Plants use sunlight to make food which animals eat. We eat both the animals and the plants.

In sunlight, our skin makes a vitamin. It is called vitamin D. We need vitamin D to make strong bones.

The heat the Sun sends us helps to make the wind and rain. You can see that without the Sun, the Earth would be very different. But once there was no Sun. One day the Sun will die, and there will be no Sun Again.

Where do tailor birds get their name?

Birds build their nests in many unusual ways. But perhaps the most surprising of all is the nest of



the tailor bird, which is clothed on the outside with wide leaves delicately sewn together with strong vegetable fibres. It uses its thin, pointed beak like a needle, punching holes in the leaves, and pulling the 'thread' through.

Where can you find magical toys?

The ballet *Coppelia* tells the story of a beautiful life-size puppet which has been modelled by the strange old Dr Coppelius. He hopes to make the puppet come alive with magic spells and by filling her with the life of a human being. He lures a young village lad called Franz into his workshop and puts him to sleep with a potion.

Dr Coppelius's evil magic is upset by a girl called Swanhilda who has been spying on him. Dressed in Coppelia's clothing, she pretends to come alive as Dr Coppelius chants his spells. The doctor thinks his magic has worked as Swanhilda dances around the room. But her dance grows so wild that she destroys everything in the workshop and then escapes with Franz.

The world's most famous ballet about toys is *The Nutcracker*. Clara is given a wonderful carved nutcracker as a Christmas present. At midnight she creeps downstairs and sees the nutcracker leading a battalion of toy soldiers into battle against the terrifying mouse king and his army. Just as the mouse king is about to attack the nutcracker, Clara throws her slipper and kills the mouse king. This breaks the enchantment and the nutcracker turns into a handsome prince and takes Clara off to the Land of Sweets. In the morning Clara awakes to discover it all was a dream.

How do we tell the time?

The Egyptians used to tell the time by observing the movement of the shadow cast by an obelisk. For measuring short periods they used a water clock, in which water flowed drop by drop from one container into another.

Sundials of all different kinds were used for telling the time from 4000 B.C. right up until the sixteenth century, but they were not very accurate. Very many experiments had to be carried out before an accurate system of measuring time was found. People experimented with candles, hour-glasses, falling stones and running water, and of course the position of the sun was known to be an important factor. In 1357 a water clock was built at Fez in Morrocco behind a face 11 metres high. Every hour a stone fell on to a gong. The face contained a number of doors and at every hour also, a different door opened. Anyone who had not heard the gong could tell what time it was by looking to see which door was open.

A sundial is an old and popular device for measuring time. As the Earth spins round on its axis a shadow cast by the Sun gradually moves round. This movement can be mapped out and the time can be read from the clock. Like the Egyptian obelisk 'clock' it can only be used in daylight and when the sun is bright enough to cast a shadow. Part of the popularity of sundials in the past - and even today is that very decorative models can be designed to grace any garden.

In 1900, part of a Greek calculating machine was found in the wreck of a boat which had sunk 2000 years previously. Experts recognized this piece as belonging to a forerunner of modern clock mechanisms. In an enormous Chinese water clock dating from the eleventh century a small mechanism was found which was later used as a regulator for clocks driven by gear wheels. It was a small metal shaft at the end of the which hung a weight. The shaft swung to and fro, alternately holding and releasing the teeth of the drive mechanism one by one. This movement produced the familiar 'tick-tock' sound of the clock.

Later this technique was perfected in mechanical clocks. At first a system of weights was used to drive the mechanism, but later people began to make watches driven by a spring. In the seventeenth century the famous Dutch scientist Christian Huygens built the first pendulum clock. It was more accurate than existing clocks and was the first to show the seconds. Huygens then went on to invent what was almost the perfect clock regulator - the balance wheel. Huygens' two inventions were important milestones in the development of clock and watch making. Later the electronic clock was invented. Atomic clocks are the most recent invention, and caesium atomic clocks are the most accurate ever made.

Watches have undergone changes over the years too - although these portable time-pieces have obviously not been in use for as long as clocks. Very accurate watches with clockwork movements have always been extremely expensive items, but since the invention of watches - and clocks - with a quartz movement accurate timepieces are available at much lower prices.

How can you build a station?

Throughout the nineteenth century, brilliant scientists, engineers and electricians produced their inventions. When the Englishman George Stephenson introduced his famous steam engine Rocket in 1829, a new idea for a toy was born. Wooden models of this famous engine and its linked carriages could be pushed and pulled along the ground.

Toy steam engines, metal replicas of the Rocket and later engines, were also made. These engines were complicated pieces of machinery, and it took a great deal of time and tinkering to get them working. Each one was decorated with brass signs and shiny paintwork and had a small boiler which worked. A standard track size, called a gauge, was introduced so that several trains could circle the track at the same time.

Modern electric trains are even more complicated. Adults and children remain absorbed for hours, setting out the track, the stations, signal boxes, sidings and sheds, and enjoying the crisscross journeys of the model engines.

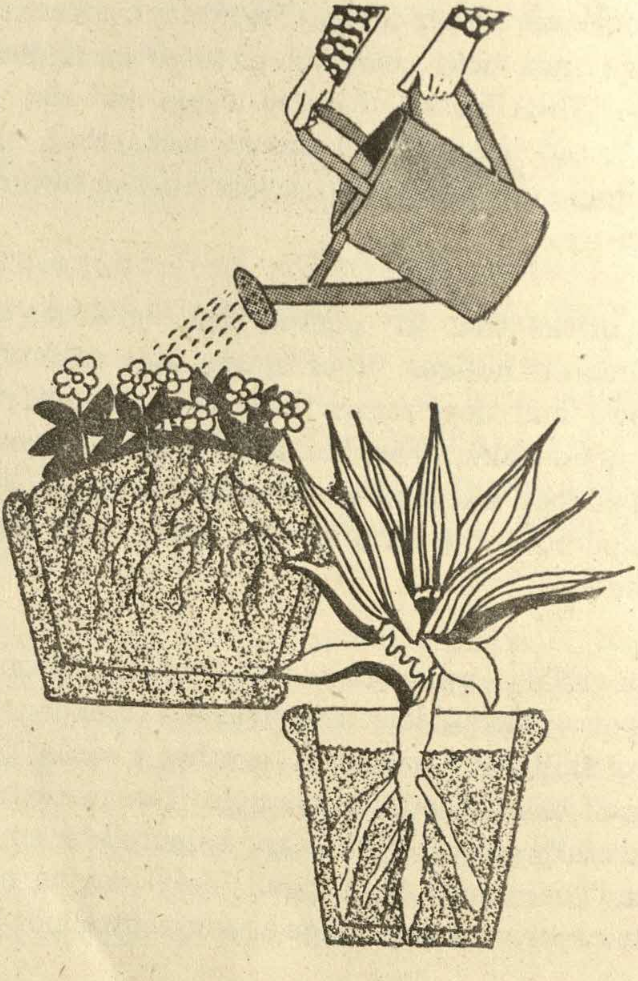
Toy bricks are simple shapes. They may be decorated on each face with colourful pictures or alphabet letters. When bricks of every shape and size are stacked and balanced on top of each other, they can become imaginary castles, lost cities or towering skyscrapers.

Small bricks that fit together can be made into complicated houses. Roof slates and chimneys, windows and doorframes help you to plan your construction like a real builder. Other kits provide metal shapes and angles which lock together using nuts and bolts and form intricate pieces of working machinery.

There are also construction toys for young aeroplane designers, shipbuilders or electricians. It takes a great deal of skill and care to put together a model glider made of balsa wood, for example. The pieces must be carefully glued together and balanced for smooth flight. There may be a small diesel engine or an electric receiver to mount on a radio controlled plane.

Why do we water plants?

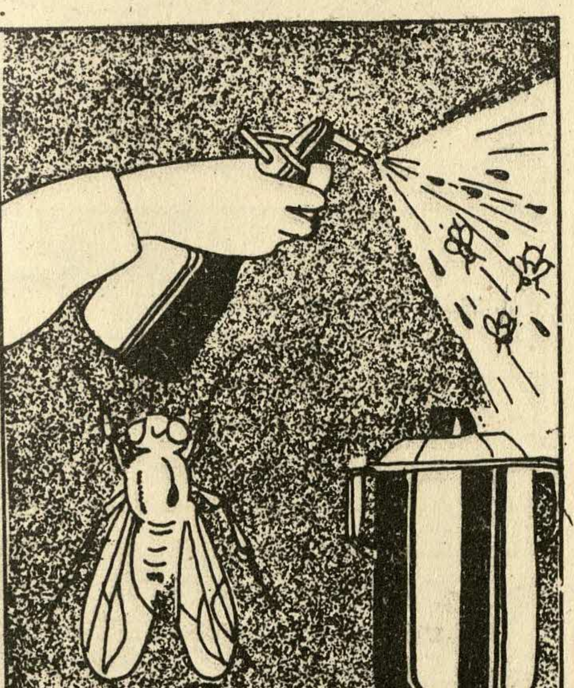
The leafy parts of plants consist largely of water and some of this is lost as the plant breathes and some dries out in the Sun. This water has to be replaced by water drawn up through the plant's roots.



Minerals the plant needs from the soil, are dissolved in the water, so this is how the plant is fed. These minerals are particularly important to green plants because they are needed for the process of photosynthesis.

Why do we kill flies with insecticides?

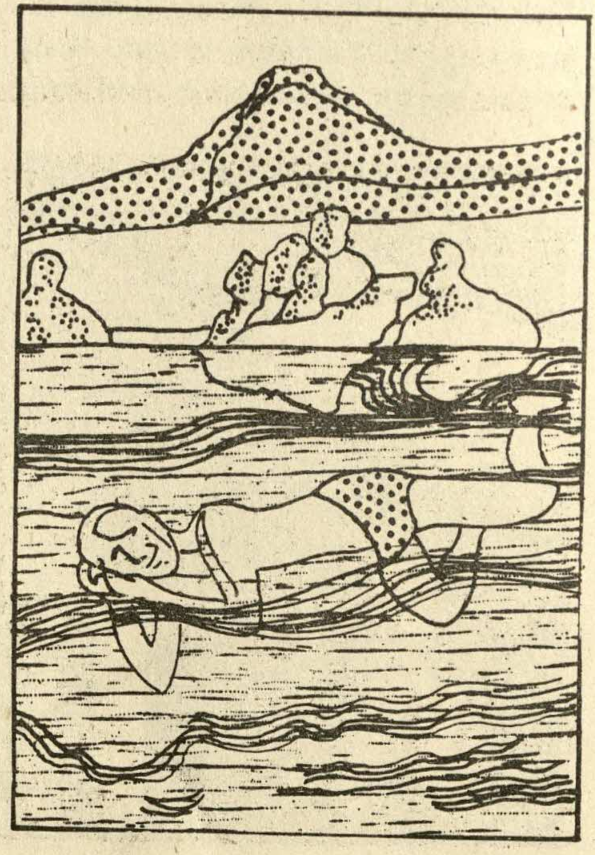
Flies live and breed in dirty, germ-ridden places like rubbish tips and carry these germs on their bodies. Man tries to kill them to stop them from spreading the germs of infection and dangerous diseases.



Spraying the flies with insecticides is one of the best ways of killing them. The sprays are unpleasant to humans, but deadly to insects, as they attack their breathing mechanism. All food should be covered when these sprays are being used.

Why can people float easily in the Dead Sea?

You may have noticed that it is easier to float in



the sea than in a swimming pool. This is because the sea water which is salty and therefore more dense, makes you **more buoyant (able to float).**

The Dead Sea, a lake between Israel and Jordan, is very salty, containing about 275 grammes (6 ounces) of salt per litre (per pint). This enables people to float on the surface without having to swim. Of course, it is not very pleasant if you accidentally swallow some of the water.

Because the water of the Dead Sea is so salty it cannot support any vegetable or animal life, apart from bacteria.

How can helicopters hover in the air in one spot?

The shape of the blades on top of a helicopter, and the speed with which they rotate, makes them produce a very strong air current beneath them. This pulls the helicopter upwards and keeps it in the air. It can stay in one spot, rise, fall or move forward, according to the way it is controlled.

Why do we get milk from cows?

All mammals need milk as a source of food during the early stages of life. Milk is rich in proteins,

vitamins and fat.

Cow's udders are very developed, and produce large quantities of milk. Because they are such gentle creatures, humans are able to milk them. Cows' milk is one of our major food sources.

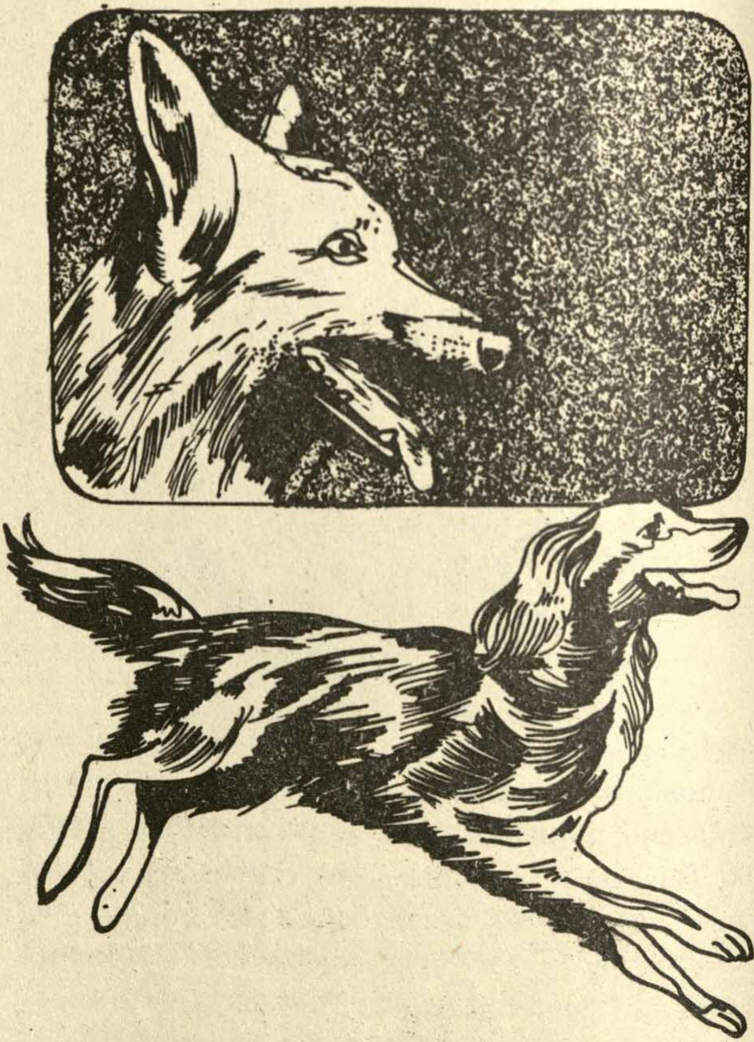
Why do some men grow beards?

Men produce a hormone (body chemical) which enables them to grow hair on the lower part of their faces. This will grow into a moustache and

beard if it is not shaved off. As early as the iron age men have chosen to shave, or to shape their beards and moustaches to improve the way they look. They have also shaved for comfort in a warm climate - beards can be hot and itchy! Because the razors they used were open blades, they were quite difficult and dangerous to use. Nowadays, with safety and electric razors available, more men choose to be clean shaven.

Why do dogs pant?

All living beings need to get rid of excess heat for



their metabolism (all the chemical processes that occur in the body) to work normally. Depending on the physical make-up of the species, this heat is lost in different ways. Humans and horses have sweat glands and pores in their skin: moisture comes out through the pores and evaporates, cooling the skin.

Whales do this through the edges of their fins. Dogs, however, have very few pores or sweat glands, and have to get rid of the heat through their tongues. This is why they pant in hot weather or when they've been running around.

Why do we have a shadow?

Rays of light, from the Sun or artificial light, spread equally in all directions. When these rays of light meet a solid object, they cannot pass through it.

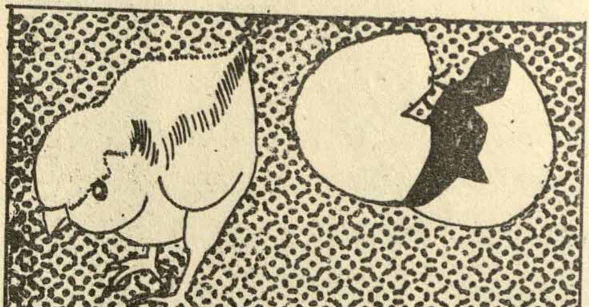
So they come to a standstill and the area behind the object is unlit. As our bodies do not let light through, we have a dark area behind us on the ground. This is called a shadow. When we move, this dark area is always with us. This is why the shadow seems to move with us.

Of course, if we are walking with the light behind us, the shadow will be in front.

Perhaps you have played a game with your friends where you run and try to 'catch' the shadows of your friends.

Why do hens lay eggs?

Hens are oviparous, or egg-laying animals. This means that they lay fertilised eggs, and the egg develops outside the mother: unlike viviparous animals such as mammals, in which the embryo grows inside the mother (as in humans). The egg,



which contains the ovum and a large quantity of food reserves, is covered by a protective shell, and if the egg is fertilised, a baby chick will grow inside and eventually break this open.

However, once a fertilised egg is laid, it has to be kept warm for the chick to develop, which is why the hen sits on top of her eggs. This is called incubation.

When do albinos occur?

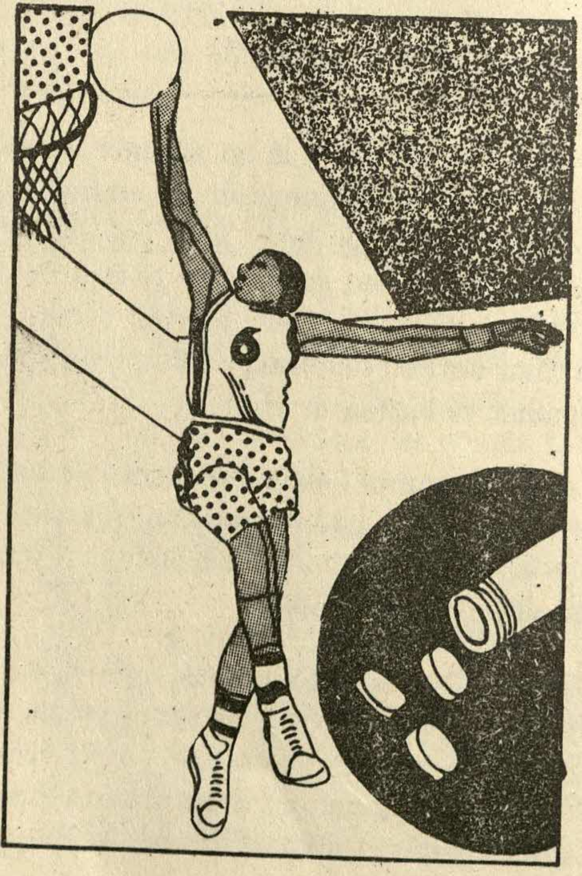
Albinos occur when there is an absence of yellow, red, brown or black pigment in an animal's eyes, skin, scales, feathers or hair. This peculiarity can be passed on from one generation to another. But albino animals do not often survive in the wild, because their normal colouring is designed to protect them against radiation or enemies.

In the case of human beings albinism is caused by the absence of the pigment melanin. It varies from complete albinism involving skin, hair and eyes, to localized albinism or spotting.

The complete human albino has milk-white skin and hair. The irises of his eyes appear pink, while his pupils take on a red hue from light reflected by blood in the unpigmented structures underneath. There is one complete albino for every 20,000 people.

Why should sportsmen not take drugs?

Certain drugs temporarily stimulate the muscles and make it possible for people to run faster or perform better in sport. This practice was fairly common in horse racing and greyhound racing. Now, this habit of drug-taking has extended to other areas of sport,



such as football, cycling and athletics. Firstly, it is considered a form of cheating if some sportsmen and athletes improve their performance by drug-taking. Secondly, in the long term, it is not good for the health of the competitors. For these reasons, sports authorities in many countries have banned drug-taking and made it illegal.

Why do some people snore?

Snoring is the sound air makes when it passes over certain parts of the mouth and throat. It is a vibration which usually happens when a person sleeps lying on his back with his mouth open. So the snoring may stop if he turns on his side. People who have catarrh often snore, because their throat and nasal cavities become coated with mucus. Smoking tobacco and drinking alcohol may also increase the amount of mucus in the breathing system. So people who

drink and smoke may snore. It is unusual for children to snore, but it can happen if the child has a bad cold.

Why do some animals kill others?

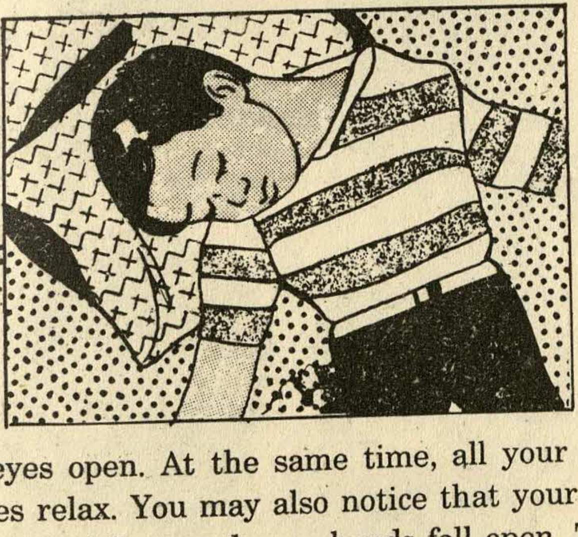
Animals don't usually kill for sport. If one animal kills another, it is usually for food, or in self-defence.

Meat-eating animals, or carnivores, kill

vegetable-eating animals, or herbivores, to eat them, as they cannot digest vegetable matter themselves. A natural circle called the food chain is established which enables the different species to survive. Man can eat both meat and vegetables (an omnivore).

Why do we shut our eyes when we go to sleep?

When you are awake the muscles of the eyelids are tightened, although you do not notice this. When you feel sleepy all the muscles begin to relax, your eyelids begin to droop and it is difficult to keep your eyes open. At the same time, all your other muscles relax. You may also notice that your arms and legs feel limp and your hands fall open. These feelings of relaxation are signs that you are tired and ready to fall asleep. When you are very tired you probably won't be able to keep your eyes open.



Why don't animals speak?

Animals communicate in all sorts of different ways; ravens caw and bees 'dance' for example. Every species has some way of transmitting information to others of its kind. This is vital for feeding, mating and warning against danger or attack.

Human speech, which is symbolic and much more complicated than that of animals, transmits a great deal of varied information, and this requires a higher level of intelligence.

How was the habit of smoking tobacco introduced?

Tobacco was discovered by Europeans in the 16th century when explorers, such as Christopher

Columbus, visited Central America. They noticed that the natives, the American Indians, smoked tobacco, thinking that it had medical properties. It was also used in Indian ceremonies, such as smoking the pipe of peace. Jean Nicot, French ambassador to Portugal, introduced it to his country, claiming that it could cure headaches. The tobacco plant was named *nicotinia* after him, and the substance nicotine, found in tobacco, also got its name from him.

Now, of course, tobacco is known to be harmful to the health and smoking is discouraged, especially among young, growing people.

What is bee's wool?

This insect was so named because it was thought that it attacked and killed bees for food, but this has been proved to be untrue. It is sometimes found in abandoned hives, where it will feed on sick or dead bees, but it usually hunts and feeds on other, smaller insects. It grows to a length of about $\frac{1}{2}''$.

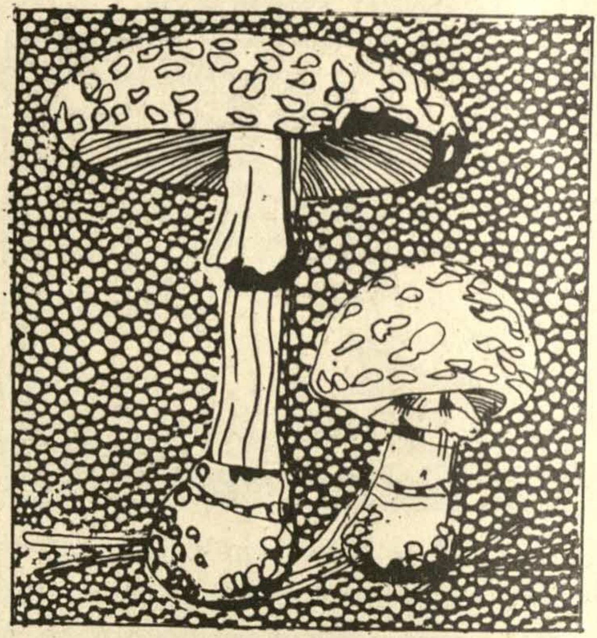
Why do we feel hungry and thirsty?

Humans need food in order to grow and remain healthy. We also need food for energy. The human body is like a machine. It converts one form of energy

into another. So the energy in food is converted by the body into other forms of energy; heat, movement and mental activity. When we need food or drink this sets off a kind of alarm system in the body. The empty stomach sends a message (via the nervous system) to the brain to make us think about food and drink. We then feel hungry or thirsty and eat or drink to satisfy our needs. When the stomach is empty again we receive another signal that we need some food.

Why is it dangerous to pick mushrooms?

Mushrooms belong to the fungus family of plants. Unlike most plants, they do not need light to grow; in fact some mushrooms spring up overnight. The toadstool is also a kind of mushroom, but it is



poisonous and can cause death or serious illness. This is why we have to be very careful when we pick mushrooms. It is safer to buy them from a shop.

If you see something that looks like mushrooms growing in a field don't pick them unless you are with an adult who knows the difference between mushrooms and toadstools.

Why is it said "an apple a day keeps the doctor away"?

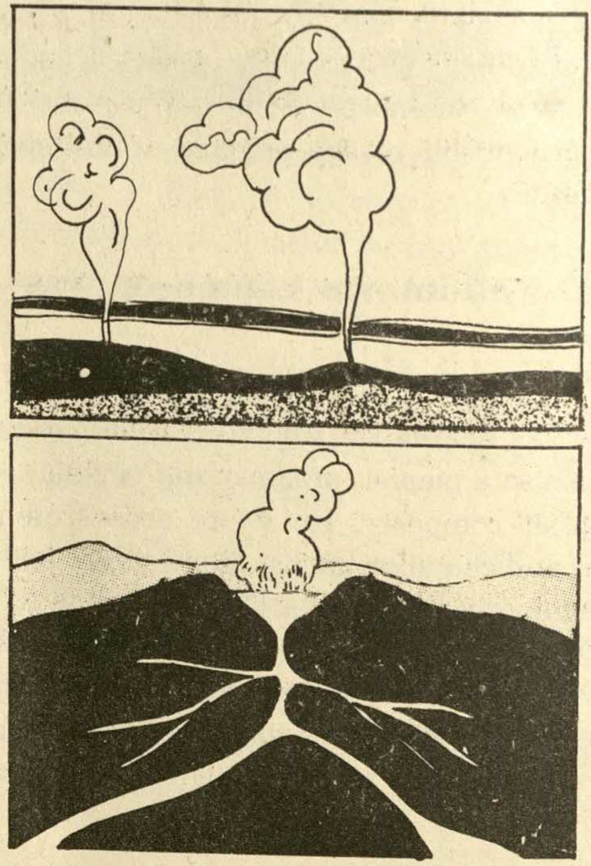
The old rhyme, "An apple a day keeps the doctor away", was a polite way of saying that this would help to prevent constipation since it was believed that the juice of a raw apple aided the fermentation of undigested foods. Although we might query such a sweeping statement these days, apples are good for you, but it is the dentist more than the doctor they keep away! Dentists will tell you that biting on a crisp crumbly apple is an effective method of removing food particles from between the teeth. Eating an apple after meals and cleaning your teeth night and morning is the best protection you can give them. To say this is not to deny the overall value of an apple and the presence of Vitamin C (ascorbic acid), as well as other minerals, lends some weight to the old adage. Some say you feel well in direct proportion to the amount of Vitamin C in your tissues.

Which well-known composer was deaf?

Ludwig Van Beethoven, who lived from 1770 to 1827. He was also a pianist, organist and violinist as well as a great composer. He wrote orchestral music, sonatas and chamber music, choral music and songs and one opera, *Fidelio.* Beethoven started to suffer from deafness in his late twenties, and the last thirty years of his life were spent in a world of silence; he was only able to hear musical notes in his own head. But he still retained his sense of humour and love of fun.

Why does hot water come out of the ground?

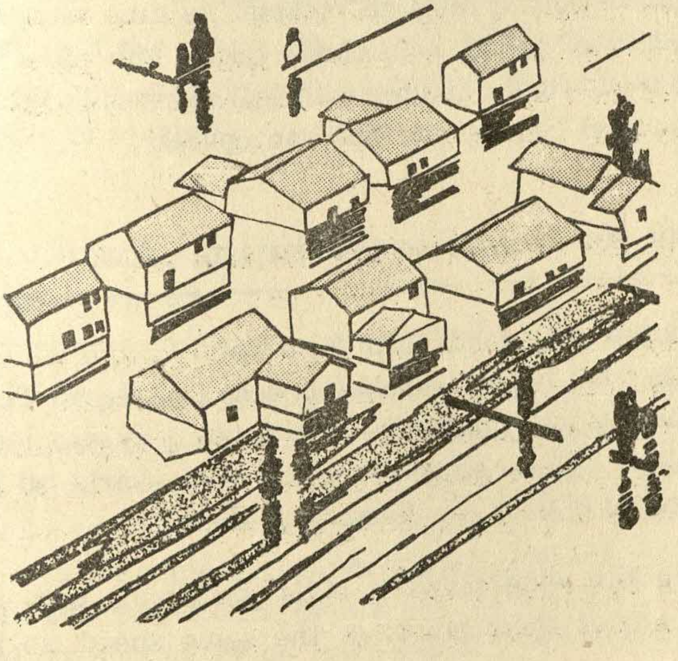
Water gushing from a crack in the ground is called a spring. If the water comes from deep down in the ground it is hot. This is because the interior of the Earth is hot. Rainwater that has gone down cracks deep into the Earth becomes heated. The hot water is then forced up out of the ground under pressure.



Some hot springs come from volcanic rock nearer the surface. These are called geysers. Hot water and steam is forced out of a tubular crack in the ground and spurts quite high in the air. There is a geyser in Yellowstone National Park, USA, called Old Faithful, because it erupts every 65 minutes without fail. It reaches a height of about 50 metres (164 feet).

Why doesn't the sea flood the earth?

The surface water of the sea is constantly being turned into vapour by the heat of the Sun. This evaporation keeps the level of the sea the same.



There is one event which could increase the volume of the sea. If the temperature around the two Poles increased, this could melt the polar ice caps. Then the water level of the oceans would rise and this could cause serious flooding of some parts of the Earth.

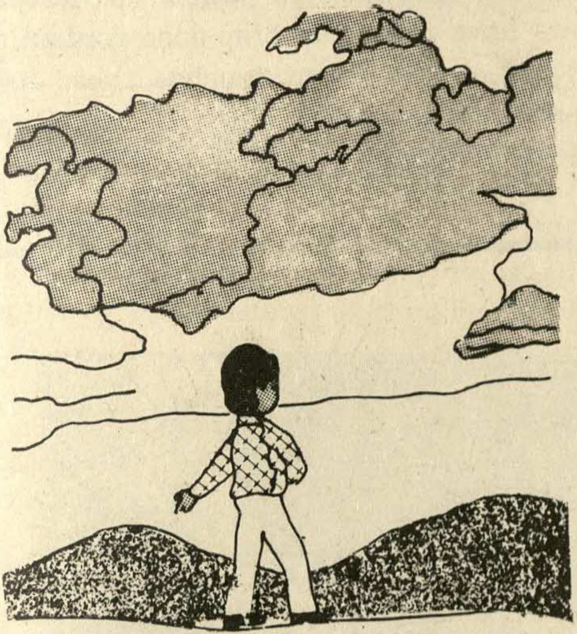
What is a Madrigal?

A Madrigal is a type of song, usually about some form of nature. They originated in Italy but became very popular in England during the 16th and 17th century. It is also known as a canzonet or ayre. At first they were sung unaccompanied and later they began to have a religious content. As time went on music was added, sometimes taking the place of one of the voices, and the madrigal was also included in several Gilbert and Sullivan operas.

How do clouds move in the sky?

We know that clouds form from water vapour which comes from the evaporation of seas and rivers. The water vapour condenses into many tiny droplets of water. These small drops fall very slowly, so it seems as if they are floating in the sky.

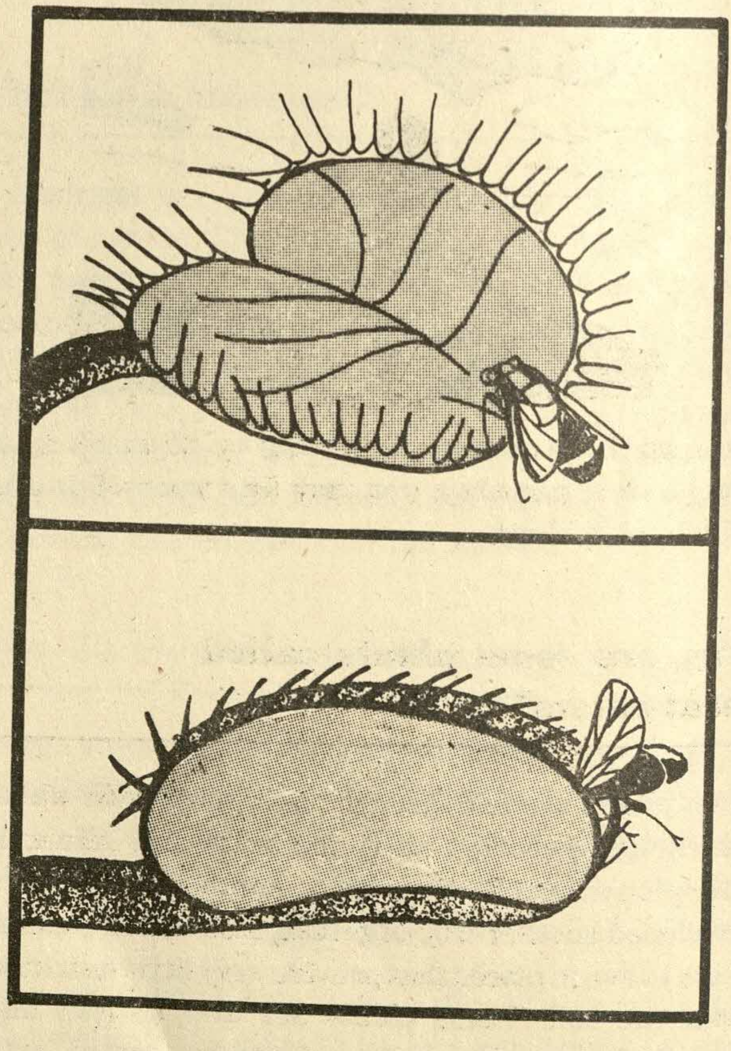
When the wind blows it pulls the clouds with it and makes them travel at the same speed, so it



looks as if the clouds are moving by themselves. If you go up a mountain you may find yourself in the middle of a cloud.

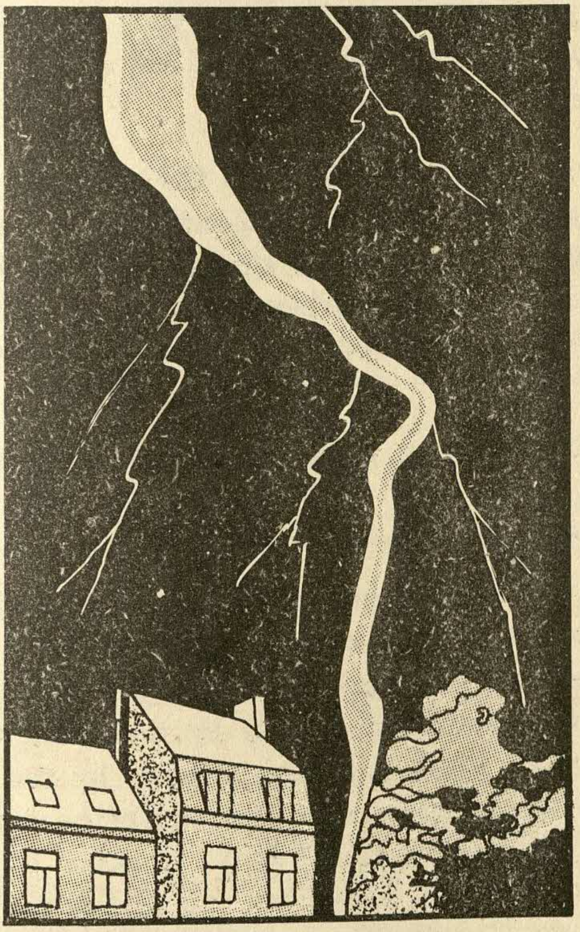
Why are some plants called meat-eaters?

Most plants are fed through their roots with water which has dissolved in it the salts and minerals the plants need. However, some plants have developed another way of getting food which enables them to live in places that provide very little nutrition from the soil. These plants are able to trap and feed on insects. Some have tentacles coated with a glue-like substance to which the insect sticks. Others have a kind of trap-door containing little hairs. When the insect touches these hairs, the trap-door closes and captures it. All these plants have special digestive enzymes to absorb the insects.



Why does thunder always follow lightning?

Storms are caused by an electrical disturbance in the atmosphere. The electrical pressure between two clouds or between a cloud and the ground gives off sparks of electricity, called lightning, and causes a rumbling sound known as thunder. Thunder and



lightning occur at the same time, but we see the lightning before we hear the thunder because light travels faster than sound. That is why thunder always follows lightning.

Why stars twinkle?

Stars often look 'spiky' because their light dazzles our eyes. They are really shaped like round globes, as the Sun is.

Stars also seem to twinkle in the night sky. This is because of air movement in the Earth's atmosphere which makes starlight twist and bend as it passes through. When it reaches us, the light therefore seems to jump around and twinkle.

What happens when you burn your fingers?

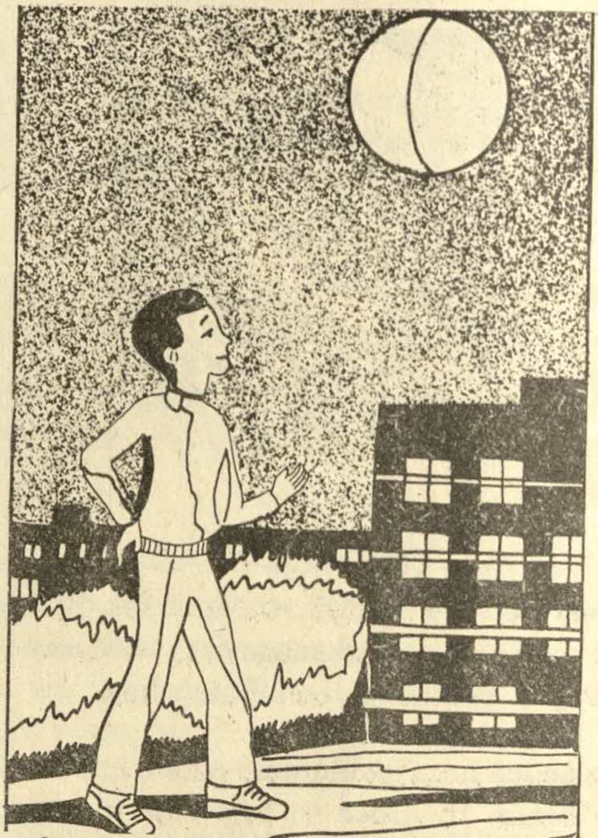
When you brush against something which is burning hot, you immediately withdraw your hand. The brain does not instruct you to withdraw your hand. The order is transmitted directly by that part of the spinal cord which has been affected by the pain. This is called a *reflex* action. The route of the message: pain - spinal cord, spinal cord - muscles, is much shorter than if it went from the seat of the pain to the spinal cord, then to the brain, then back to

the spinal cord and finally to the muscles. This saving in time minimizes the damage that is caused when, for example, you touch something hot.

A reflex action is an involuntary action not controlled by the brain. In order to over-rule a reflex, the brain has to act extremely powerfully, so that free will can intervene. This can only happen from a certain age, when we are well in control of our nervous system.

Why does the Moon seem to move with us?

If we look at the Moon when we walk outdoors at night, it seems to be moving with us. In fact, the Moon moves much faster than we do. But, because



it is so far away, it appears to move at the same speed.

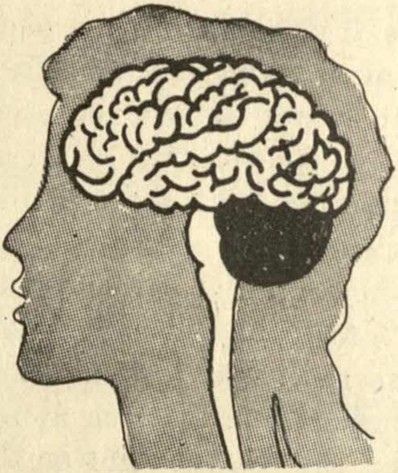
To appreciate its real change of position we would have to cover distances so great that we would need to travel in a space ship. So the appearance of the Moon moving with us is just an illusion.

How far away are the stars?

The spacemen who went to the Moon took three days to get there. It would take them many months to get to the Sun. But the Sun is much nearer to us than any other star. A spaceship would take thousands of years to get to the next nearest star. It's hard to imagine that sort of distance in kilometres. So scientists use another way to measure the distance. They use the words 'light year'. A light year is how far light travels in a year. To us, light does not seem to take any time to get from one place to another. Aim a torch at a wall and switch it on. You will see the light on the wall at once. But really the torch light takes a split second to get from the torch to the wall. The farther the light has to go, the longer it takes. If you aimed your torch at the Moon, it would take just over a second for someone up there to see it. Light takes eight minutes to get from the Sun to us. But light from Proxima Centauri, the next nearest star, takes four whole years.

Who gives the orders?

The body is regulated with a very precise and fine adjustment. To regulate breathing, for example, there are nerve centres in the brain stem (medulla oblongata). The stem is a continuation of the spinal cord, which widens just behind the brain. The amount of carbon dioxide contained in the blood puts these nerve centres into action. These centres control inhalation (breathing air in) and exhalation



(breathing air out). From the top to the bottom of the brain stem, the instructions alternate: Breathe in! Do not breathe in! Breathe in! Do not breathe in! Breathe in! In the end, there are three instructions to breathe in for every two instructions not to breathe in. As a result of these continuous adjustments, the 'breathing machine' operates at maximum efficiency., to meet the body' requirements.

Why do white people have red cheeks when they come back from a winter walk?

Who has not experienced the surge of warmth which fills the face, when entering a warm room after a cold walk? In humans, as in all warm-blooded animals (birds, mammals) the temperature regulation of the body results from a balance between systems

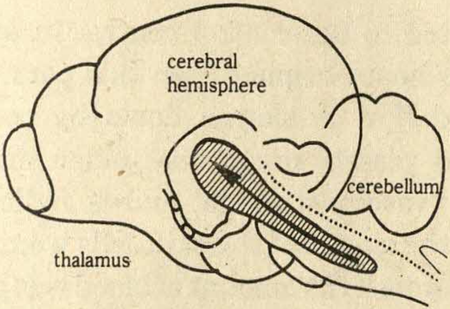


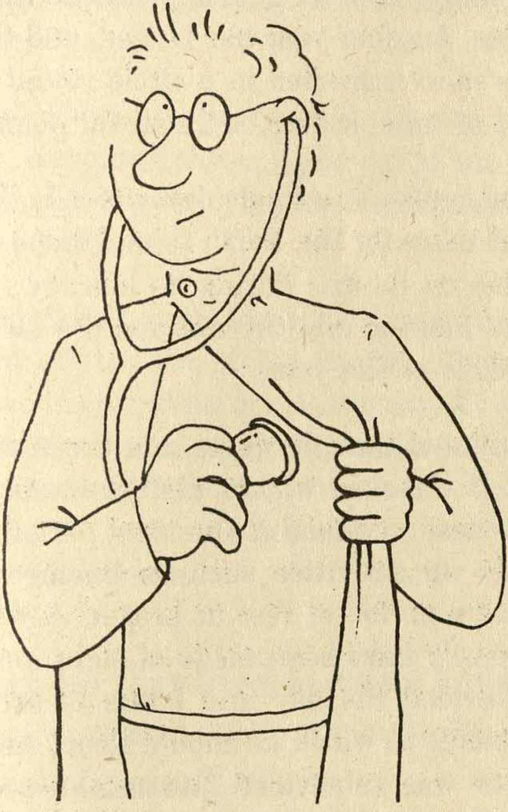
Diagram showing the hypothalamus in the brain.

producing heat and systems dispersing heat. This balance is constantly checked against variations inside and outside the body. When we do something energetic, the body gets hot; when we leave a house where it is 20°C (69°F) to go into a street where it is only 5°C (41°F), we get cold. The adjustment of the various systems is controlled by a part of the brain under the cerebral hemispheres called the 'hypothalamus'. This control centre receives information from the outside by means of small organs under the skin, which are sensitive to heat and cold. It receives information from the inside from receptors, which react to the blood temperature.

The blood plays a role of primary importance in distributing heat around the body. To some extent, it is like the water circulating around the radiators and pipes in a central heating system. But what happens when it is cold? The face, which is usually uncovered, is particularly cold. This feeling is transmitted to the control centre. In order to stop too much heat escaping from this part of the body, the blood flow is slowed down by contraction of the blood vessels circulating under the skin. This is called 'vasoconstriction' and is indicated by the pallor of the skin. But the skin cells would eventually freeze and die if the amount of blood was permanently restricted. And so, from time to time, the blood vessels in the skin disobey the orders from the hypothalamus (the part of the brain concerned with temperature control) and dilate. This periodic vasodilation causes the flushes of heat which give a 'healthy appearance'. Apparently, when we return from a walk in the winter cold, the hypothalamus itself orders the vasodilation of the blood vessels. It is then not just a small flush which rises in our cheeks, but a great surge of heat, resulting in red cheeks.

Why do heartbeats make a noise?

It is impossible to put your ear to your chest to listen to your own heart beating. And not everybody has a stethoscope to listen to his neighbour's. However, films and documentaries have let you hear the very characteristic rhythmic beat, which modern composers have sometimes imitated in their music. It is the heart valves that produce the familiar double heartbeat sound, known to doctors as 'lub' and 'dup'. The first sound, which lasts for approximately



one-tenth of a second, is dull and muffled; the second, which follows fairly closely, is shorter and sharper. These two sounds are followed by a relative silence (approximately half a second for a person at rest). Sometimes a third sound is heard, one-tenth of a second after the second sound.

How is time subdivided?

The clock strikes twelve midnight. People wish each other a happy new year and everyone sings *Auld Lang Syne*. Another year has passed, and the Earth has once more travelled in a circle round the sun. The unit of time, in fact, is a natural phenomenon.

The same applies to a single day, which is the length of time it takes for the Earth to make one complete revolution on its axis during its journey round the sun. The months and the seasons are also natural subdivisions of the year.

Other units of time, however, are the work of man himself. It was man who created the week of seven days, because he found it the ideal period in which to divide up activities such as business, and to introduce a period of rest or prayer. A week could just as easily have been made of eight, or six days. He subdivided the day into hours in order to fix the moments at which he should sleep, eat or work. The hour was subdivided into minutes, and later these minutes were themselves divided into seconds. Today, hundredths and thousandths of a second are used in areas such as space travel and competitive sport, where it is necessary to be completely accurate. Races can be lost or won, and world records broken by such minute amounts of time.

Who had a Chariot of Gold?

Long ago, people believed that the Earth stood still and the sun took a journey across the sky each day.

The ancient Greeks believed that the sun was the god Apollo, travelling through the sky in his chariot of dazzling gold, drawn by eight magnificent horses with golden harnesses.

They thought that each morning Apollo rose from the bottom of the sea in his chariot. During the day he drove in splendour across the sky. As twilight came, he plunged once more into the waves, where a golden ship waited to carry him home again. In the morning, he mounted his chariot and started his journey once more.

Why do polar explorers catch colds more easily when they return to a temperate climate?

There are very few microbes (minute living organisms), which cause diseases in polar regions because the climate does not favour them. The cold does not kill them - it simply puts them 'into storage', and prevents them from reproducing or multiplying. For obvious reasons, this climate is not much favoured by humans and few people live at these latitudes. There are not, therefore, many carriers for the germs of disease. As a result, the polar air contains very few microbes, and people who stay for several months in these icy regions gradually lose their natural resistance to undesirable microbes, simply because they are no longer coming into contact with them. As a result, the bodies of polar explorers no longer contain those special cells (anti-bodies) for combating certain illnesses. Why continue making cells which have no use? Gradually, over a period of several weeks, the anti-microbe barriers are lowered.

When the Arctic or Antarctic explorers return to warmer climate, where people live in large numbers, they have no defence against the germs, which are now able to develop and multiply freely in their bodies. Fortunately, the body can quickly re-erect the barriers. In between time, those people who have lived for many months in air which is *very pure* suffer heavy headcolds, which make the nose and eyes red.

It is not only germs which make the nose run. Dust and flower pollen are sometimes responsible. Most of us are used to these and those people who never get used to them are said to be 'allergic'. Polar explorers also become unused to them, and the reunion which takes place between nose and dust and pollen is nothing less than spectacular!

How the Sun spins?

By watching sunspots, astronomers can see that the

Sun keeps turning round. This spinning motion is called rotation. A sunspot appears on one side of the Sun. Then it moves across the Sun's face. Finally it disappears round the edge. It is carried round as the Sun turns. By watching sunspots, astronomers have found something odd. All of the Sun does not spin at the same speed. The part near the middle of the Sun takes about 25 days to go round. Near the poles, the top and bottom of the Sun, sunspots take 31 days to go round.

Different parts of the Sun can turn at different speeds only because it is made of gas. If the Sun were solid like the Earth, all of it would spin together.

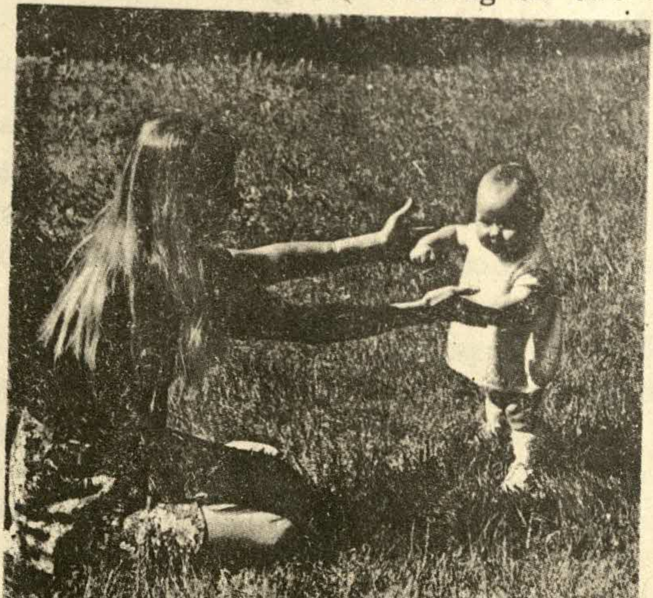
Why are salt tablets given to people working in a tropical climate?

When you work in a hot atmosphere, you sweat freely. Sweat is a secretion; a discharge of water, salts and waste products, such as those found in urine. The salt contained in sweat is extracted from the fluid in which the blood cells float. When you drink after perspiring a lot, the water you swallow is not retained because there is not enough salt, and you perspire even more. And so, the salt loss has to be made up, in order to retain the water. You can even prevent excess sweating by taking salt tablets. This is a wise precaution before undertaking sustained activity in a very hot climate.

This practice should not be continued for a long time, however, because over a long period the kidneys may become overstimulated, overworked. We should never interfere unnecessarily with the body's natural functioning - Nature must not be forced.

Why does a child have to learn to walk on two feet?

It still seems curious that if a child is reared away from his natural surroundings, that is, far away from the company of people, he does not walk on two feet, but on all four like the animals around him. However, it is also true that the new-born child has a natural instinct for walking on two feet.



Immediately after birth, doctors check a certain number of reflexes (involuntary actions), including the reflex for walking. When the baby is held so that his feet are on a firm surface, he straightens his legs as if to stand and lifts one leg as if to take a step. This is known as the 'step reflex'.

These reflexes disappear shortly after birth as the nervous system matures and learned movements become possible.

How do sunflowers get their name?

The head of the sunflower is round and flat with bright yellow petals like the Sun's rays. During the day it turns its face to follow the Sun, making sure it gets the maximum amount of light. Hence the name sunflower.

The plant is used in various ways. Its leaves are used as fodder for animals, the seeds can be eaten raw or roasted, and are also harvested to make sunflower oil. The yellow flowers are used to make dye.

What is a Sitar?

A Sitar is a type of lute often played in India. The word comes from a Persian word meaning three-stringed, but in fact most sitars have four, five or even seven strings. The body of the instrument is shaped like a pear, and on the long neck are placed wire bars known as frets, which can be moved up and down to suit the way the music is played. The pegs which appear at the top of the neck of the instrument are used to tune the sitar, which is played on one string only for the melody, the others providing a background noise.

Why do we grow old?

Scientists have evolved three main theories to explain why we grow old. The first concerns the loss of cells or of irreplaceable parts. Brain cells undoubtedly die off in their hundreds of thousands and cannot be manufactured again after a very infantile stage in human life.

However, this cannot be the complete explanation because people who suffer heavy damage to brain and body do not necessarily show the effects of ageing. Moreover, animals have totally different ageing rates, but suffer cell destruction at similar speeds.

A second theory concerns mutations or alterations. A dividing cell does not always divide correctly. All kinds of errors may creep in, aided by natural radiation. Sometimes the mutated cells may be harmful or put out of commission, with powerful effects on other cells, such as the endocrine glands or constituents of the blood. In the 1960s this theory was supported by the discovery that 10 per cent of the cells of very old women had lost an X chromosome.

A third explanation, which is not now so widely believed, is concerned with the accumulation of unwanted chemicals. It is suggested that some vital substances can only be replaced at cell division and that a general decline in the rate of cell division could lead either to a lack of needed substances or an excess of unwanted ones.

What and How do astronomers observe?

Astronomers do not usually look through telescopes. They use telescopes to take photographs of the sky. Photographs taken over a long time can show fainter things than the eye can see. Astronomers can also take television pictures of the sky. They guide the telescope by remote control. Astronomers also use special equipment that tells them how bright stars are.

Why is the urine red when we have eaten beetroot?

Urine, the yellow fluid secreted by the kidneys and excreted through the bladder and urethra, is 96 per cent water and 4 per cent solid constituents, the most important being urea and uric acid.

The kidney is an organ which purifies the blood. In addition to keeping the blood in the best possible condition for the body, it also gets rid of any undesirable substances in the blood, as far as it is able. Coloured substances, such as those found in beetroot, are not at all necessary to the body, so they are eliminated by the kidneys and the colouring appears in the urine. Do not panic, therefore, if you have red urine, after you have eaten beetroot. It is not blood, just the juice from the vegetable.

Where is the world's largest island - apart from Australia?

The largest island in the world is Greenland - if we exclude mainland Australia, which ranks as a continent.

Most of Greenland, which has an area of 840,000 square miles, lies within the Arctic circle. More than 708,000 square miles are covered with ice. Greenland is about 1,650 miles long and nearly 800 miles wide. In the extreme north it is separated only by a 25-mile wide strait from the Canadian Arctic archipelago.

The island is divided into two natural regions. One is the coastal region, where the mountains rise out of the ice. The other is the ice sheet, which covers more than four-fifth of the country, burying all valleys and mountains far below its surface. The highest mountain in Greenland is Mount Gunnbjorn which rises up to 12,139 feet. As the whole country lies north of the tree line there are no forests, but in the south-west groups of trees do grow up to 10 feet in height.

The polar climate is uncertain and changes suddenly from bright sunshine to dense fog or heavy falls of snow. Temperatures can vary from 10° Centigrade (50° Fahrenheit) in July on the coast to about -47° Centigrade (-52.6° Fahrenheit) in the interior. The lowest recorded temperature in winter was -65° Centigrade (-85°Fahrenheit).

Greenland forms a part of the Danish kingdom. In 1960 its population was 33,140. The islanders speak both Danish and Eskimo.

How do aeroplanes fly when they are so heavy?

The flying mechanism of an aeroplane is quite different from that of a bird. There are two main reasons why it flies. The powerful engines push it forward with an enormous thrust of energy, and the design of the wings creates greater pressure under the aircraft than above it when it moves forward. This low pressure sucks the aeroplane up into it, so we can say that they fly suspended in the area of low pressure they produce above their wings.

Can you name three percussion instruments?

The percussion group of instruments includes all instruments that you strike, so you can include the triangle, the xylophone, the glockenspiel and, of course, drums: from the tomtom and timpani to the African bell drum and the bass and side drums. Other popular percussion instruments are the tambourine, the cymbals and the gong.

Why do we have a temperature when we are ill?

When we are ill our body's activity increases to overcome the infection and our temperature rises. Having a high temperature is not, however, a sign of bodily weakness. A temperature is a means of defence. The evil microbes which sometimes invade the human body live very happily at a temperature of 37°C (98.4°F), which is normal body temperature. If it is one, two or three degrees higher, the microbes begin to feel uncomfortable, and the white corpuscles can act more efficiently on them.

The white corpuscles devour the bacteria, and then transfer a substance to the blood, which will be carried by the circulation to a region of the brain where the temperature is regulated. Heat production is increased. While this is happening, an unpleasant period of shivers, of surface coldness is experienced, because the heat which was escaping is now retained to the maximum, within the body. The blood circulates more slowly in the skin, so that the 'skin radiator' seems to be colder. The shivers are only movements of the skin muscles, which produce even more heat as they function.

The need to cover up or sit beside a source of heat is a very natural reaction. It has been shown that reptiles, such as a lizard, have a similar reaction when they are ill. They sit close to a source of heat or sunbathe.

What blood group did the first people belong to?

By studying the blood group of different populations around the world, backed up by important work done in the laboratory, scientists first thought that primitive Man was type O and Rhesus + - two of

the best known systems. But now it is thought that the A, B, O systems all originate from a single system, although it is difficult to know exactly how. How can we take a blood sample from a skeleton which is some tens of thousands of years old! However, it is thought to have resembled group O.

Why does a bull charge red? It doesn't!

An angry bull will charge at anything that moves. It need not be a red rag. Bulls are colour blind and cannot see red or any other colour. But by tradition the cloak of the matador, or bullfighter, is red on one side. This adds to the colour and excitement of the bullfight.

The bull is specially bred to be savage and strong. When the matador waves his red cloak, the bull gets angry. He charges the matador, who sidesteps gracefully to avoid the bull's sharp horns. Finally the matador pierces the bull with his sword.

Although many people believe bullfighting is cruel, in Spain and South America the sport has been admired for centuries as a display of daring and skill.

How did puppet shows begin?

For hundreds of years Punch and Judy shows have been performed in many countries. At seaside resorts and fairs, children cluster around the small red and white striped puppet theatre and laugh with delight at Punch's naughty antics.

Punch probably came into being in Roman times, when actors wore strange masks to act out their plays. Much later on, in France, Punch became the puppet we know today, with his hooked nose, hunchback and squeaky voice. He was first brought to England over three hundred years ago, and other characters were introduced to act in the plays. Today he has a wife called Judy and a baby. There are also a doctor, a police officer, a hangman and a devil.

Punch causes dreadful trouble by knocking the other puppets over the head with his stick. He always avoids punishment and everyone else takes the blame. His dog Toby is his only friend. Toby frightens away the devil with the bells on his neck frill.

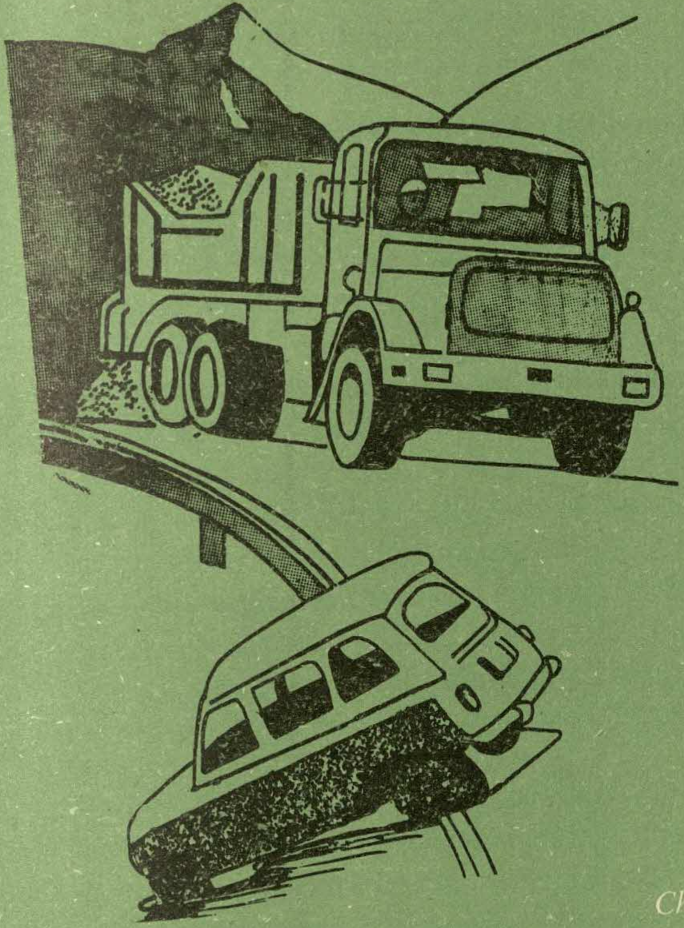
The early puppet theatres travelled from town to town entertaining people with ancient legends, the adventures of bold heroes, fables and many of the Bible stories. Many different kinds of puppets were used all over the world.

String puppets or marionettes are wired to a crossbar. The arms, legs, head and body can all be made to move independently and perform very lifelike movements.

A glove puppet fits over the hand. The first and second fingers support the puppet's head, and the two end fingers and thumb work its arms.

A sock puppet is pulled over the arm and the clenched fist forms the head. Finger puppets fit onto each finger and cannot be moved so freely.

Shadow puppets were invented many centuries ago by the ancient Chinese people. The limbs of these flat cut-out figures are attached to sticks. As the puppets move between a strong light and the backcloth, they throw moving shadows in silhouette.



Chapter 4

Science & Technology

Why is fertilizer needed?

Plants contain chlorophyll, and this enables them to make their own sugar with the sun's rays, so that they have their own food supply. But at the same time there are certain elements in the soil which are essential for good crops. The plant absorbs them as it absorbs water, by its roots. The essential elements are nitrogen, phosphorus, potassium and magnesium. Small quantities of copper, manganese, zinc and iron are also needed. At harvest time these elements are removed from the soil at the same time as the plant, and so the ground has to be fed with fertilizer to prevent it becoming unproductive. Formerly, horse manure was the chief fertilizer used. It is still used widely, but additional chemical fertilizer is also needed to produce good harvests.

In spite of the great advantages of chemical fertilizers, manure is still essential for agriculture, since it contains organic elements which improve the quality of the soil. If the same crop is grown year after year, the soil will eventually become exhausted, so that, as well as spreading fertilizer, it is sometimes necessary to rotate crops, allowing each field a year in which to lie fallow.

When was the first blood transfusion?

The first successful blood transfusion on record was performed in 1665 by Richard Lower. Using quills and silver tubes, he transferred the blood from the artery of one dog to the vein of another. Two years later, he transfused a man with the blood of a lamb. He gave a demonstration of this before the Royal Society in London, and the incident is recorded in the diary of Samuel Pepys.

Richard Lower was able to perform these transfusions thanks to William Harvey who, in 1628, announced his theory of the circulation of the blood. Before Harvey, people had always realized that blood was vital to life, but they did not know how it circulated in the body.

A vital development in blood transfusion came in 1900, when Karl Landsteiner demonstrated the different blood groups in human beings. After that, people were transfused with blood of their own group whenever possible.

Nowadays blood transfusion saves many lives. People can be treated for shock by pumping plasma (the fluid part of the blood) into them. Large reserves of blood are necessary for open-heart operations, sometimes as much as 20 pints a patient.

What are the main activities of forestry?

Although forests are valued for the opportunities they offer for recreation, wood production nevertheless remains an important factor. Forestry is making sure the woodland is well kept and grows properly. The forester cannot cut down trees as he pleases, he needs to think which trees are ready for cutting and which will need to be replanted. A section of forest which has been cleared should be replanted in the autumn with young trees from a nursery. The plantation is usually enclosed by a wire fence to protect it from deer and the animals, who might break down or eat the young trees. For the first few years, all the forester needs to do is to remove the weeds which tend to grow around the young shoots. These would kill the tree by taking all the nourishment from the soil. Later, the tree needs to be surrounded in such a way that light reaches it only from the top while it is growing. This helps it to grow straight upwards and reduces the number of side branches. It also avoids the formation of knots in the wood. From time to time the plantation is thinned out, and any diseased wood or trees with irregular growth, such as a double or crooked crown, are removed. Trees which are hindering the growth of others are also cut down. If the thinning has been carried out properly, the trees will reach their standard height with a minimum number of side branches in fifty years. Later the plantation may be thinned further so that the best trees can have enough space to develop properly. After ninety to a hundred years, the trees are cut down with a power saw. The tops, side branches and bark are removed, and the wood is then sold to a sawmill, paper mill or other concern which used wood as a raw material.

What are the most primitive forms of textile production?

Long ago the natives of Africa and South America beat and crushed bark and used the fibres to make textiles. In South America blankets were produced by this method. The same technique is still used to produce textile fibres in the Pacific islands around the Equator. The men choose a suitable tree, which must be neither too young nor too old, and remove the bark by scraping it off with seashells. The women then soak the bark in water, leaving it for several days. The strips of soaked bark are then placed side by side on a broad wooden plank, and crushed with a block of wood. In this way large sheets of material resembling cloth are made. Another form of textile production consists of beating and pressing wool or animal hair which has been treated with grease so that it will form a felt-like textile. This method is found particularly among shepherds who keep long-haired flocks, such as the nomad tribes of Asia. The felt is made by the women outside their tents, while the men have the task of keeping the flocks.

Are all textiles woven?

No. Clothing can also be knitted. In this case wool or thread is used, and is knitted or braided with long needles. Nowadays there are even knitting machines.

Spun fibres can also be used to make lace on a bobbin. Belgian lace made in this way is world-famous.

Thread can also be worked with a crochet hook. This is a long needle with a hooked end which is used to pass the thread through the loops in the crochet-work.

Why do medicines come in different forms?

Medicine is given in different forms because of the necessity for convenience or for speed. It can be given by mouth (orally) in the form of tablets, capsules or draughts. It can be inhaled in the form of gases, fine aerosols or, very rarely, exceedingly fine powder. Injections of medicine are given subcutaneously (beneath the skin), intramuscularly or intravenously. Sometimes solid implants in the form of tablets may be placed subcutaneously. Injections may also be given in the spine or brain.

Medicines can be given through the rectum as solids (suppositories) or enemas, or through the vagina as pessaries or douches. Finally, there are solutions, powders, creams and ointments which are placed locally on the skin.

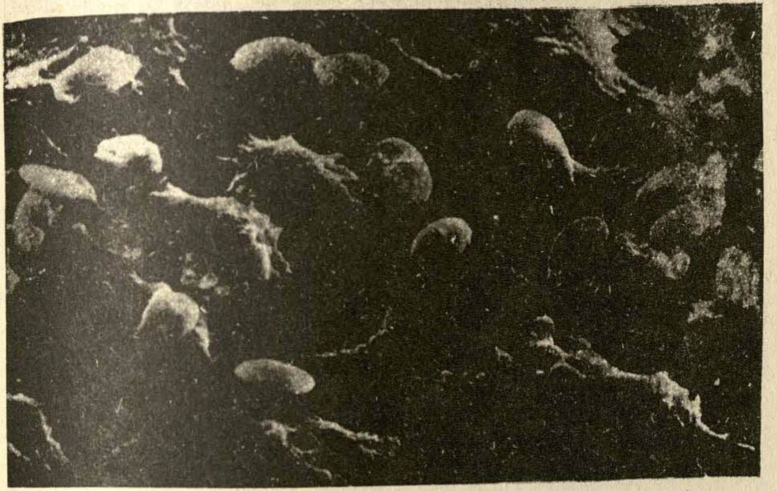
Convenient medicines are those which can be taken or administered easily by the patient himself. Oral medicine and inhalations are convenient and a great deal of research is carried out to make these more palatable.

Manufacturers prefer oral preparations because they can be attractively coloured and flavoured and made impressively mysterious in size and shape. They can also be code-stamped or named for identification. Injections have to be sterile and kept in appropriate containers and are therefore relatively expensive.

What is cancer?

Cancer is what happens when the normal cells making up a part of a person's body start to grow faster than usual, take an odd shape, and stop their part of the body from doing its work.

If the cancer lump is found early enough, it can sometimes be removed by surgical operation or killed by treatment with X-rays or gamma rays. But if this is not done soon, stray cells break off from the cancerous part and float off in the blood to start



trouble elsewhere.

Cancer can start in almost any part of the body - the lungs, the kidneys, the stomach, the bones, the blood and even the skin. No one really knows why cancer starts. But ideas are becoming clearer about what makes people likely to get cancer, and doctors are keen to stop people doing things - like smoking cigarettes - which they think may encourage the disease.

Where was copper first used?

Copper was known in Europe at an early date and used in the making of bronze during the Bronze Age, but some of the Indian tribes of America knew how to work it before its discovery by the Europeans. The Yellowknives, who lived in Canada, for example, used it for making axes and knives, and it was from this that they got their name.

They used to prospect for copper in the mountains along the River Coppermine. The Yellowknives were highly respected by the other tribes, until the Europeans came and sowed discord among the Indians.

In Peru and Mexico the use of copper had been known for centuries. It was also worked in Africa and Asia. One disadvantage of this metal was that it was relatively soft. Stone objects were more resilient.

What is paper and how is it made?

Paper is sometimes sold as sheets and sometimes sold in rolls. It is used as a packing material and is also used for writing and printing.

The Egyptians learnt to use a material made from the papyrus reed for writing on. The word ‘paper’ is derived from papyrus. Because papyrus does not decay, Egyptian scrolls have survived for many years. Paper was originally made from vegetable fibres which were wetted and pressed together on top of one another. It is claimed that paper was discovered by the Chinese some two thousand years ago. It made its appearance in Europe between 1000 and 1100 A.D.; before this, people had written on parchment. The vegetable fibres used for paper-making in Europe did not come directly from plants, but from linen rags. Thus the fibres were used twice over. Paper making was an early application of a technique which has become very common today and which is known as 'recycling'.

In the sixteenth century paper of excellent quality was being made from linen rags. About a hundred years later, the introduction of a new method using wood chips as a raw material enabled paper of the same quality to be made much more cheaply. Books became cheaper and newspapers were printed in greater numbers. Waste paper can now be pulped and used again.

What in fact is a machine?

If we take a construction set and make a device full of turning wheels and shafts, can we say that we have made a machine? Not really, for by the term machine we understand a device which uses energy to perform some useful task by cutting down the amount of effort needed. This task can be of many different kinds. The machine can make our work easier, or it can speed it up. Cranes and pulleys make work easier for us by lifting heavy weights from the ground. And there are many different machines which speed work up for us.

What is an engine?

An engine is a very special type of machine, which transforms a quantity of energy, of a type which does not produce movement, into mechanical energy. Primitive forms of this type of machine are the sails of a ship, windmills and water-mills. The first two use the force of the wind, the third uses water as its propulsive force. Later, machines such as the steam engine, the petrol engine, the diesel engine and the electric motor were introduced.

All these machines still make use of natural forces. The force which they use is called energy. No machine could work without using some form of energy.

What medical instruments did the Romans use?

Some 200 surgical instruments of various kinds have been discovered in the ruins of Pompeii but, in general, the contribution of Rome to medicine was not very great.

'The Romans', said Pliny, in the 1st century A.D., 'got along without doctors for 600 years'. In fact, if it had not been for the Greeks they might well have never had any. In the early days the Romans relied on herbs and salts as well as some horrible potions like gladiators' blood and human fat. The first Greek doctor to win fame was Asclepiades in about 91 B.C. and he insisted upon regular diet and exercise, fresh air and cleanliness. Galen (c.A.D. 130-200), the most famous of all, emphasized the need to study anatomy.

Drills, scalpels, tweezers, forceps and even a four-jawed clamp were used as surgery, through trial and error, became more skilful. Fractures and dislocations were treated effectively and artificial legs were not unknown. However, there were no anaesthetics and antiseptics and many operations, such as appendicitis were beyond the surgeon's skill.

Where does energy come from?

Our bodies are not capable of producing enough energy for the work which these machines have to do. We have to find it elsewhere. We get it from the air, from burning coal or oil, from exploding gases, and so on. It is widely available in nature - in the wind, in rivers, in lightning - but we cannot always make use of it. The basic forms of energy are heat and light. Sometimes the amount of energy available and the difficulty of controlling it is quite frightening, as is the case with atomic or nuclear energy. Recently, people have been successful in capturing the energy of the Sun on solar panels, which are used to transform the Sun's heat into electricity.

What is the difference between a petrol engine and a diesel engine?

The name itself indicates one difference, which is in the fuel used. One runs on petrol, the other on diesel. The latter is more economical, but the real differences lie elsewhere. A petrol engine has several cylinders, each with a spark plug in its head. A spark plug is a small device which produce sparks at regular intervals. These sparks are necessary to induce the explosion of the compressed mixture of petrol and air which drives the engine. The diesel engine also has cylinders inside which explosions take place: however these are not produced by a spark plug, for a diesel engine does not have any. Instead the vapour inside the cylinder is compressed with such force that it heats up and explodes of its own accord. Diesel engines are more robust than petrol engines.

What does an X-ray show?

X-ray are electromagnetic rays of very short wavelength which can penetrate matter through which light rays cannot pass. We call this opaque matter. An X-ray photograph shows a picture of the internal structure of the body allowing doctors to diagnose broken bones to examine the organs of the body. In order to show the position and shape of the stomach and intestine a harmless material such as barium is swallowed, and other opaque substances may be injected to show the outlines of other organs. Oxygen can also be injected into the brain to make its outline sharper.

The discovery of X-rays was recorded in January 1896 by Professor Rontgen, Professor of Physics at Wurzburg. Chest X-rays led to the early diagnosis of pulmonary tuberculosis and from these beginnings the science of radiography and radiotherapy developed until now countless X-ray installations are in daily use throughout the world. X-rays are used both to diagnose and to treat deep-seated diseases like cancer. Scientific laboratories use them in experiments while industry uses them in work of investigation. By using high-tension apparatus giving up to 300,000 volts, steel can be examined for faults and hidden weaknesses can be discovered in aeroplane construction.

What is electricity?

Electricity has existed in nature since the beginning of time, being visible in the form of lightning. The ancient Greeks discovered that when wool was rubbed against amber, the two were attracted to each other (the Greek word for amber is elektron). This phenomenon, which is known as static (i.e. not moving) electricity also occurs with modern synthetic materials. It cannot however be used as a source of energy. The electricity which we make use of today is dynamic (i.e. mobile); it is in fact an electric current. In order to understand the nature of electricity, we must know something about the structure of the atom. An atom consists of a positively charged nucleus with one or more negatively charged particles - electrons - revolving around it.

The atoms which go to make up metals have a characteristic peculiarity, which is that some of the electrons are not fixed around a particular nucleus, but move freely through the metal. For this reason they are called 'free electrons'. If all these electrons can be made to move in the same direction, an electric current is produced. This can be achieved by joining the ends of a piece of metal, usually a copper wire, to a source of current, such as a battery. The strength of the current is measured in amperes, named after Andre Marie Ampere, a French physicist who lived from 1775 to 1836, and who did much research on this subject.

When was acupuncture first used?

Acupuncture originated in China as a form of medical treatment about 2,500 years ago. It has been practised by the Chinese ever since.

The treatment involves the insertion of small metal needles into one or many of 365 spots on human body. Each of these spots, designated by ancient Chinese doctors, represents a particular function or organ of the human body. Accordingly a heart or liver line can be traced by linking the appropriate spots which relate to the particular organ. If a patient has eye trouble the needles will be inserted into his eye line, which may not necessarily come anywhere near the eye. The needles do not go deep, and are not painful. A single treatment may last only 10 minutes.

It is not clear why acupuncture works, but some scientists have suggested that the needles may relieve the nerves affecting a disease.

Since the beginning of this century the treatment has been introduced in the West. At first there was much scepticism, but recently acupuncture has been widely accepted and has been found to be not only a cure but also a valuable form of anaesthetic.

How is electricity transported?

Electricity is moved from one place to another through copper or aluminium cables running above or below ground. Surface cables are less expensive than underground ones, since they do not need to be insulated, although they do have the disadvantage of disfiguring the countryside. The electricity which leaves the generating station is not taken directly to the consumer, since this would result in considerable losses of energy. The current which travels along the cables produces heat, and this heat increases as the current gets stronger.

In order to reduce the loss of power through heat, the strength of the current must be reduced by raising the potential or voltage. For this reason the current first passes through a transformer which raises the potential to 275,000, sometimes 400,000 volts. It can then be led to its destination along high-tension cables running over long distances. On arrival, the voltage is reduced to some 11,000 volts in sub-station. The current then passes along underground cables to the transformer stations which can be found in every residential district. There it is brought down to the standard voltage 240 volts, and enters our homes as low-tension current, which can then be used for lights and domestic appliances.

What is resistance?

When water is pumped through a pipe, it is held back to a greater or lesser degree by the walls of that pipes. The longer the pipe, the greater the loss of power induced by this resistance. It is easy to see that the resistance of a narrow pipe will be greater than that of a broad pipe. The material which the pipe is made of is important also. If it is smooth, it will offer less resistance than if the internal walls are rough or grooved.

In an electrical cable, the free electrons moving along it are held up every time they come into contact with the atoms which the wire is made of. The principle is the same as for the pipe. The longer the cable, the greater is the number of collisions between electrons and atoms, and hence the greater the resistance. Thin wires offer greater resistance than thick wires. Again, the material the wire is made of is important - an iron wire will offer greater resistance than a copper wire of the same thickness and length.

Some materials have a very high resistance, i.e. the current has great difficulty in passing through them. These materials are called insulators, and they include glass, plastics, porcelain and rubber. Another factor influencing resistance is temperature. When the temperature rises, the atoms move rapidly to and fro within the wire. This movement causes more collisions with the free electrons and so restricts their movement. Thus the higher the temperature the greater the resistance. There are some exceptions to this rule which we will not deal with here.

The unit of resistance is the ohm, named after the German physicst Georg Simon Ohm, who lived from 1789 to 1854.

When was the thermometer invented?

The first practical thermometer or instrument for measuring temperature was invented shortly before the end of the 16th Century by the famous Italian astronomer Galileo. It was an air thermometer giving only a rough indication of the degrees of heat and cold, and later he increased its efficiency by using alcohol instead of air.

The principle on which thermometers work is that the liquid or gas used for measuring expands or contracts with changes in temperature more rapidly than the glass containing it. Thus when a colour liquid is confined in a thin glass tube the difference in expansion, as shown by the level of the liquid against a graduated scale, indicates the temperature.

About 1714 the German scientist Gabriel Daniel Fahrenheit designed a thermometer which, for the first time, used mercury as the measuring agent. He also introduced the scale named after him in which 32° is the freezing point of water and 212° the boiling point. Mercury is still used in most thermometers because it has a high boiling point (674°) and a low freezing point (-38°).

An alcohol thermometer, still in use in some countries, was made by Rene de Reaumur, a French naturalist, about 1713. About 11 years later Anders

Celsius, a Swedish astronomer, used the centigrade scale for the first time, with freezing point at 0° and boiling point at 100°

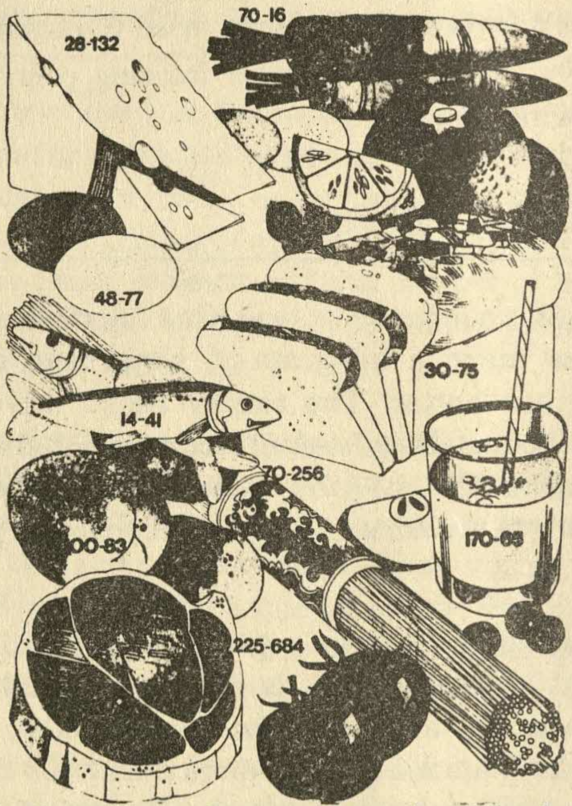
What is a calorie?

A calorie is a measure of heat. One calorie is enough heat to make a kilogram of water one degree Centigrade hotter. The energy which drives the human body is also measured in calories. When people talk about the calorific value of food, they are referring to the amount of energy it gives the person who eats it.

The amount of energy a person uses decides the amount of food needed. It depends on how big a person is and how much exercise is taken. A big, muscular lumberjack needs more than 2,500 calories a day, while a small secretary, who sits at a desk all the time, cannot take in more than 1,400 a day without getting fatter. Children need more calories for their size than adults because growing uses up energy fast.

When people put on weight it is because they are taking in more calories than they are using up in energy, and the extra is being stored as fat. The reverse is also true.

Calorific value is not the same as nutritional value.



The body also needs special kinds of food to keep healthy. So people who are trying to lose weight must still eat a good deal of meat, or other form of protein, and vegetables. If they cut these out, their bodies will be undernourished and vulnerable to illness.

What are Siamese twins?

Siamese twins are babies who are born joined together. They are joined by a bridge of flesh through which the blood flows from one twin to the other. So the twins share the same blood circulation systems.

The name "Siamese" originated from a famous pair of such twins from Siam who were exhibited for many years in the 19th Century.

Nowadays, with the great advances in medicine and surgery, it is often possible to separate the twins, enabling them to live freely and independently from each other.

How does an incandescent lamp produce light?

An incandescent lamp consists of a glass bulb containing, under a vacuum, a metal wire wound in a double spiral, which is very thin and therefore of very high resistance. When electricity is passed through this filament, the free electrons meet so much resistance that they produce heat. The wire is heated to a very high temperature and starts to burn, giving off light. Filaments can reach temperatures of more than 2000°C, and must therefore be made of a material with a very high melting point. Edison, who invented the incandescent lamp, used carbon filaments. Today they are made of tungsten, a metal which melts at around 3400°C.

Tungsten also has the advantage of giving an increased resistance at a very high temperature.

How does a fuse or circuit-breaker work?

When the current in an electrical circuit becomes too strong, there is a danger that it will cause a fire. A fuse or circuit-breaker is therefore put in as a safety measure. A fuse is made of some insulating material such as porcelain and contains a thin wire which has a very high resistance. Any electrical current coming into the house has to pass through such a device, and if the intensity of the current reaches a certain level the wire melts with the heat produced and cuts off the supply, thus preventing the electrical circuits from overheating. Fuses are classified according to the maximum current they can withstand. Thus there are fuses rated at 2 amps, 13 amps, 15 amps and 30 amps. The disadvantage of the fuse is that once it has melted either the wire or the whole fuse, according to the type, must be replaced. For this reason devices known as circuit-breakers are now being introduced, which do away with this problems. They have an automatic-mechanism which cuts off the current when it becomes too high, but can be reconnected simply by pressing a button. Before replacing a fuse, or pressing the button on a circuit-breaker, the cause of the short-circuit must be traced and remedied, otherwise the fuse will blow, or the circuit-breaker drop out again. Aircraft often have complicated electrical systems which must be protected, and on many modern airliners you can see an impressive array of circuit-breakers.

When was the stethoscope invented?

The stethoscope was invented by a French doctor, Rene Theophile Hyacinthe Laennec, in 1816. His stethoscope was a perforated wooden cylinder one foot long, and he got the idea for it from the sight of children scratching one end of a wooden beam with a pin and listening to the transmitted sound at the other end.

He put one end of the tube to his patient's chest and listened to noises made by the heart and lungs. He gathered evidence of what these sounds meant by comparing the various noises heard in living patients with the type of disease seen after they died. In 1819 he published his findings in one of the great books of medicine *De I'Auscultation Mediate*, and the stethoscope soon came into general use.

Auscultation (listening to sounds within the body) is most commonly used in diagnosing diseases of the heart and lungs. Nowadays a stethoscope is generally binaural (for both ears) and has two flexible rubber tubes attaching the chestpiece to spring-connected metal tubes with earpieces. In listening it is often necessary to use both a bell-shaped, oepn-ended chestpiece for low-pitched sounds, and a flat chestpiece covered with a semirigid disc or diaphragm for highpitched sounds. Many modern stethoscopes have both kinds of chestpieces readily interchanged by turning a valve.

When was the iron lung invented?

The iron lung was invented by Philip Drinker of Harvard, United States in 1929. This machine enables people whose lungs are paralysed by disease or accident to breathe. It does so by alternately reducing and increasing the air pressure round the patient's body. When the pressure is reduced, his chest expands and air streams into his lungs through the normal air passages in his head which is outside the machine. When the pressure is increased, the chest contracts and air is automatically expelled from the lungs.

This life-preserving apparatus is a tube on wheels in which the patient lies on a foam rubber bed with adjustable head and foot rests. It is operated by electricity, but has a safety device which gives a warning signal in the event of a power cut. The machine can then be operated by hand.

The cover on top of the iron lung can be opened to give access to the patient. When this is done, the patient's head is usually enclosed in a plastic dome in which the air pressure is alternately raised and lowered to enable breathing to continue.

How do musical instruments produce sound?

A musical instrument produces sound waves which travel through the air and make our eardrums vibrate. The main types of musical instrument are wind instruments, stringed instruments and percussion instruments. The 'string' family includes the violin, the cello, the guitar and the mandolin.

Wind instruments are made of brass or wood. They are instruments in which sound waves are produced by blowing into a mouthpiece.

In percussion instruments, the vibration of the air is produced by striking by hand or with sticks, a skin stretched over a wooden or metal cylinder which acts as a resonator.

How are sounds recorded?

In bygone days, songs, like stories, were transmitted by word of mouth. Much later a system of signs was devised which enabled music to be written down on paper and read by the musician. But the greatest revolution of all came when Thomas Edison invented the gramophone. This machine works on the following principle. The performer speaks, sings or plays an instrument in front of a microphone. A fine needle travelling over a disc or cylinder receives the vibrations caused by the sounds and engraves them in a series of small grooves. The grooves form a spiral running towards the centre of the disc, or from one end of the cylinder to the other. Once the disc, or record, has been cut, a hard matrix is made from it and this allows a series of reproductions of the record to be produced. If we then replace the gramophone needle on the disc and set it turning, it will vibrate in the same pattern as it did during the original recording. This time, however, the vibrations are fed to a loudspeaker, and the words, the music or the song which were recorded can be heard once again. A more recent discovery is the tape recorder. This device does not use a disc or a cylinder, but a tape which is covered with small metallic particles. Sound is recorded on to the tape, these metallic particles are magnetized by an electronic process in a particular pattern. When the tape is passed through the machine again, it is 'read' by the recorder and the sounds are reproduced in the same pattern as that in which they were recorded.

When was aspirin first used?

Aspirin was first introduced into medicine in 1899 by H. Dreser of Germany. The word aspirin is actually the trade name for a preparation of acetylsalicylic acid.

During the last century many preparations of this acid were introduced for medical purposes, but Dreser was the first person to produce one which was considered satisfactory.

The main ingredients of aspirin occur naturally in the flowers, fruits, leaves and roots of many plants. the South American Indians were familiar with the beneficial effects obtained from the bark of sweet birch and the leaves of the wintergreen shrub, which produce a medicine very similar to aspirin.

Aspirin is widely used for the treatment of headaches, sickness, colds and influenza. But too many aspirin tablets, instead of relieving the patient, may cause dizziness, headaches and sickness, and so they should be used carefully.

When was penicillin discovered?

Penicillin was discovered in 1929 by Sir Alexander Fleming, then a professor and lecturer at the Royal College of Surgeons in London. He wanted to find a substance which would kill bacteria but would not also poison the tissues of the patient's body. Fleming discovered penicillin by accident while he was researching into influenza. He was examining a staphylococcus, a kind of germ, when he noticed that it had created a bacteria-free circle of mould around itself. When he experimented further, he discovered that this liquid mould, which he named penicillin, prevented further growth of the staphylococcus germ even when diluted and made 80 times weaker. Also, penicillin had no poisonous effect on the human cells.

Sir Alexander Fleming published his results in the *Journal of Experimental Pathology* in 1929.

For some time it was thought that there was only one penicillin, but later it was discovered that the mould could produce four penicillins. They were distinguished by the letters F, G, X and K. The best known is penicillin G, which came into widespread use after the Second World War.

What is a source of light?

The sun is the chief natural source of light. When it disappears, darkness falls. After a great deal of painstaking investigation, scientists discovered that the Earth itself does not emit light, nor does the Moon. They also demonstrated that in our solar system the planets, like the Earth and its satellite the Moon, revolve around the sun in a perfectly regular orbit.

Issac Newton performed a number of brilliant and amazingly simple experiments which enabled him to define the composition of solar light. What we call 'white light' is in fact made up of a wide range of different colours. By using a piece of glass called a prism, Newton was able to split light up into its different components and in this way discovered the 'solar spectrum', which consists of seven colours: red, orange, yellow, green, blue, indigo, (a very dark blue) and violet. In fact we don't need a prism to see all these colours, we have only to look at a rainbow.

When was the first human heart transplant?

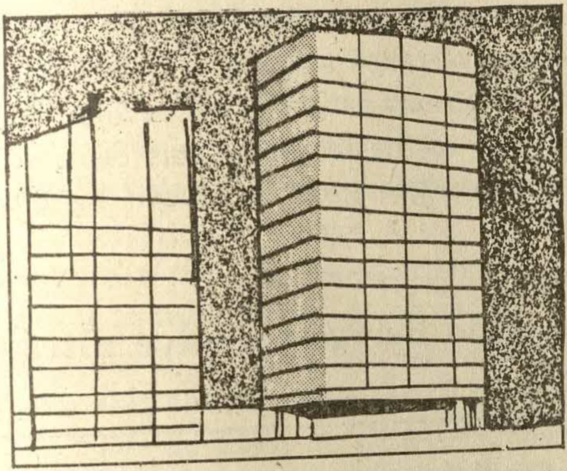
The first human heart transplant took place on December 3, 1967 at Groote Schuur Hospital, Cape Town, South Africa. A team of 20 surgeons, headed by Dr Christiaan Barnard, operated on Louis Washkansky, aged 55, using the heart of a 24-year-old donor, Denise Ann Darvall, who had been killed in a road accident.

Both the donor and the recipient were of the same blood group and the heart was kept in cooled oxygenated blood for more than three hours before transplantation. The operation took five hours and the new heart was only half the size of Washkansky's. The operation itself was a success, and within a few days Washkansky was sitting up, eating and talking happily. The doctors were anxious about transplant rejection by the body and also post-operative infection which, in fact, did kill Washkansky within a month of the transplant.

In January 1968 a second transplant was carried out on Philip Blaiberg, a 58-year-old dentist, who subsequently overcame a severe liver infection and lung condition, thought to be the result of his body trying to reject the new heart. By the end of 1968 more than 100 transplants had been carried out in the United States, Britain, France, India, South America, Canada, Czechoslovakia and Israel. More than 40 patients survived. Blaiberg remained alive until August 17, 1969 and other patients survived for up to two and a half years, but the number of operations declined. From December 1970 to May 1971 only six operations were performed. Caution took the place of optimism.

Why don't skyscrapers fall down?

These tall buildings, which dominate the skyline in some big cities, are certainly not rigid in structure. If they were, they would fall down. On the contrary,



they are designed and built in such a way that they are quite flexible. In architectural terms, this is known as the co-efficient of elasticity. Skyscrapers sway slightly in strong winds and earth tremors. In fact, they are able to withstand quite strong earth tremors and quakes.

How does a magnifying glass work?

A magnifying glass is a curved, clear piece of glass called a *lens*. If we hold it close to an object, the lens spreads out the light rays that pass through it. Our eyes see the spread-out rays, which make the object appear larger than it really is.

How does a light bulb work?

Inside a glass light bulb is a frame made of glass tube, a glass rod, and wires. This framework support a coil of wire called a *filament*. When we turn on a lamp, electricity enters at the bottom of the bulb and travels to the filament. This becomes so hot that it glows, giving off the bright light we need to see.

Can some beings perceive ultraviolet light?

This question is important since ultraviolet rays can in some cases be harmful to human beings. However, we cannot see them with the naked eye, whereas it has been proved that bees, for example, are perfectly able to perceive them. For bees, ultraviolet rays are a kind of light. This can easily be proved by shutting the bees up in a box whose only opening is a small hole. If a red light is placed in front of the hole, nothing happens, but if a source of ultraviolet light is shone at it the bees start to move towards the hole. It would appear that red is not a visible form of light for bees, whereas ultraviolet is, since they are attracted to it. Ultraviolet rays are carried in sunlight and feed the skin with the vitamin D which they contain. Vitamin D prevents a terrible disease called rickets. Infra-red rays cannot be perceived either by the human eye. They are so called because of their wavelength, which is greater than that of light. They are used in medicine for therapeutic purposes, because they are able to penetrate the tissues of the body. Infra-red, ultraviolet and X-rays all belong to the great family of electro-magnetic radiations. Radio waves also belong in this class; they can travel anywhere, including through a vacuum and interstellar space, at the same speed as light - 300,000 km a second. Ultraviolet rays, which are found in minute quantities in sunlight, are harmful to the eyes, and can also be dangerous for the skin if it is exposed to them for too long. When sun-bathing, it is advisable to take precautions to filter out the ultraviolet rays. Many commercial sunbathing creams have screens that will do this, but not all - so it is wise to check.

When can electric shocks help to cure people?

Electric shock treatment, or electroconvulsive therapy, is sometimes used with people suffering from mental illnesses in which severe depression is the main symptom.

It was first used in 1938 by U. Cerletti and L. Bini in Rome, and was recommended for the treatment of manic-depression and schizophrenia (literally, "splitting of the mind").

The technique of electroconvulsive therapy is to place two electrodes on the temples of the patient and pass alternating currents through his head. This causes him to lose consciousness immediately and is followed by a convulsion of the body. It is claimed that the patient is much calmer and better-balanced when he regains consciousness. In general, treatment is given three times a week for periods from two to six weeks. Some acutely disturbed patients, however, have been given as many as two or three treatments in a day.

This treatment has become less common since the discovery of tranquillizing drugs which reduce feelings of anxiety and agitation without to many side-effects.

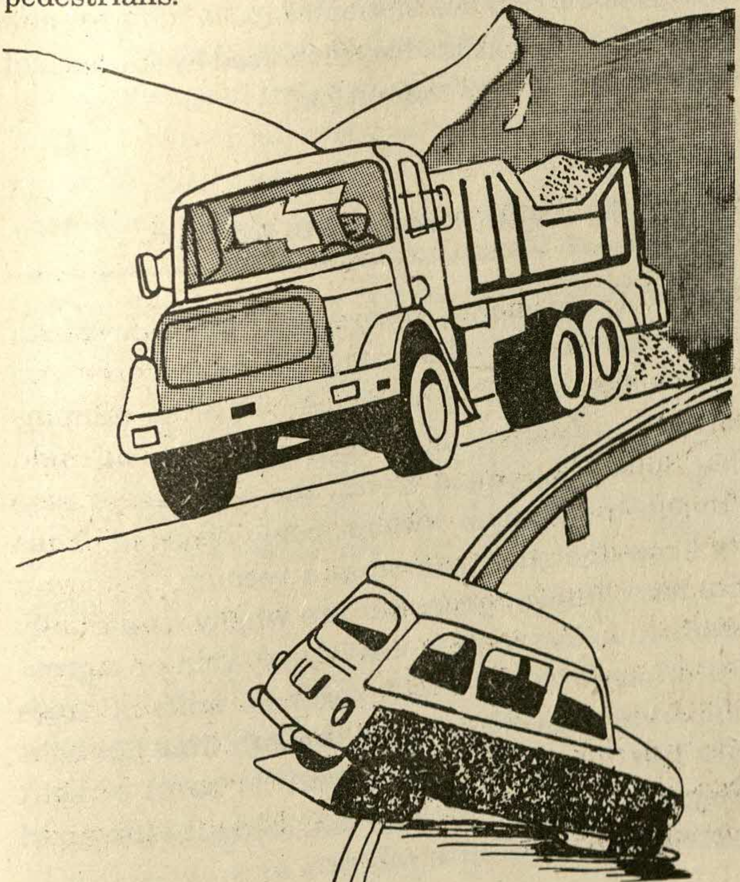
Weak electrical shocks are also used in physiotherapy to stimulate muscles wasted by disease.

Which tree is favoured for making the best woodwind instruments?

The laburnum. This tree, with its lovely hanging blossoms and delicate leaves, has heartwood (the wood below the bark) of a rich, dark-brown colour which is exceptionally stable and dense, with good resonance, too. Not thick enough to be used for construction purposes, laburnum wood is used to make flutes, oboes and the chanters and drones for bagpipes.

Why is salt sprinkled on roads when it snows?

When snow comes into contact with salt it does not freeze. If snow is expected, or just fallen, lorries go out to spread a mixture of grit and salt on the roads. This stops the snow from turning to ice, which would make the roads dangerous for vehicles and pedestrians.



What well-known everyday object did Walter Hunt invent?

By bending a piece of wire into an unusual but safe shape, Walter Hunt rediscovered a simple device used thousands of years ago: the safety pin. Three years later, in 1849, Hunt obtained the patent for his new discovery, having supplied the Patents Office with a sketch and description of his wonderful new invention, which in fact had been used by the ancient Romans to hold up their togas!

How can light really be defined?

This is an extremely controversial question which scientists have not yet been able to answer. However, if we empty a bell jar of the air which it contains and pass a beam of light through it, we will find that, unlike the sound waves, the light waves pass through the vacuum without being diverted. Thus we know that they can cross a vacuum. They can also pass through glass, but are wholly or partially absorbed by fog, clouds, mist, heavy rain or a great deal of snow. Solid objects such as walls or trees will not let a single light ray through. Nor can light rays turn the corner of a street. A beam of light always travels in a straight line, unless it is diverted by being reflected in a mirror.

Trees have leaves which look green because they absorb all the coloured light waves except green; a post box looks red because it absorbs all the coloured light waves except red.

When were antiseptics first used?

Antiseptics were first used in 1865 by a surgeon called Joseph Lister, in London. He was helped by his knowledge of the work of Louis Pasteur, a French doctor, who had discovered that putrefaction (rotting), was caused by live bacteria and not by a chemical process.

Lister, thought that bacteria could be destroyed before they entered a wound and poisoned it. He first tried the treatment on a compound fracture. Carbolic acid was applied to the wound in the hope that this would provide a barrier against the germs in the atmosphere. The experiment was successful and led to a great advance in surgery. Various kinds of antiseptics came into general use to combat bacteria.

Which is the best place for observatories?

To see into space, we have to look through the air that surrounds the Earth. If there is dust in the air, it makes the stars look dim. Clouds may hide the sky completely from the ground. Also, the air is always moving about. The view that an astronomer gets of the sky is often not very steady.

Astronomers try to get above as much of the air as possible. They do not build observatories in smoky cities. They like to build observatories on the tops of mountains. The tallest peaks stand above the clouds. Up there the air is clearer. There are famous observatories on Mount Wilson and Mount Palomar in California. Street lights in nearby towns are now starting to make the sky glow brightly at night. The astronomers are having to find even more far away places to get a look at a completely dark sky.

Which was the first disease to be defeated by vaccination?

During the 18th century 60,000,000 Europeans died of **smallpox**, yet today the disease is rare, thanks to a principal advanced by Dr. Edward Jenner (1749-1823).

Ancient country lore said that contraction of *cowpox* (transmitted from cows to humans through sores on the udders during milking) prevented smallpox. Jenner investigated thoroughly, and on 14 May 1796 innoculated an eight-year-old boy with cowpox, producing a mild illness. Later he injected him with smallpox, which was successfully resisted.

Vaccination the injecting of material which causes formation of antibodies and resultant immunity, has since been used to prevent such diseases as cholera, polio and typhoid.

How does a piano make music?

There is more to a piano than the black and white keys you see. Inside there are more than 200 metal strings stretched from one end of the piano to the other. When you strike a key, it makes a small wooden hammer hit certain strings. That makes the strings move quickly back and forth, or *vibrate.* The vibrating strings make a noise, which you hear as music.

How is oil drilled?

A drill pipe is sunk deep into the seabed, more pipes being added to lengthen it, and make a long, watertight tube.

At the bottom tip of the tube the drill bit spins around at a tremendous speed, gouging out a circular hole in the rock of the seabed, about the size of a dinner plate. It is called the borehole.

The drill bit is made from hard steel which is shaped into powerful metal teeth. These wear down very quickly, so they are studded with industrial diamonds for extra strength. Diamonds are harder than rock, so they do not wear down during drilling. They are not the diamonds set in jewellery, but have been specially cut, heated and dipped in chemicals.

The bit gets hot as it drills. It is cooled by a muddy mixture of chemicals pumped inside the watertight tube. This 'mud' carries away the loose rock chippings and keeps the hole free of rubble.

As the 'mud' flows back up the tube, it passes through a filter. All the rock pieces are cleaned out, and the pure 'mud' travels back up to the top of the pipe, ready to flow down the tube again.

Scientists on the oil rig examine the 'mud' carefully, looking for loose chippings containing drops of oil. If the 'mud' is frothy with tiny bubbles or trapped air or gas it might be that the drill has struck oil, as gas and oil are often found together.

When the bit pierces the spongy rock that contains oil, the gassy air fizzes up the borehole in a great spurt, bringing the oil with it. After millions of years the gas and oil have found a way to escape.

But the thick 'mud', moving up and down the pipe, traps the escaping oil. A great tap, called a valve, is fitted over the drill hole, The oil flow can now be turned on and off like running water.

The many pipes and valves, spread all over the oilfield, are nicknamed Christmas trees.

When is a Caesarean operation necessary?

A Caesarean operation is necessary for the surgical delivery of a baby when a natural childbirth is difficult or impossible. The surgeon makes an incision into the mother's abdomen and delivers the baby through the wall of the womb. The operation owes its name to the belief that Julius Caesar was born by this means. Deliveries of this kind were certainly known in ancient times. They are even mentioned in the Jewish law book, the Talmud, which dates back some two thousand years.

In the 19th Century, three-quarters of those who underwent such an operation died due to primitive techniques. Now they are nearly always completely successful.

What is magnetism used for?

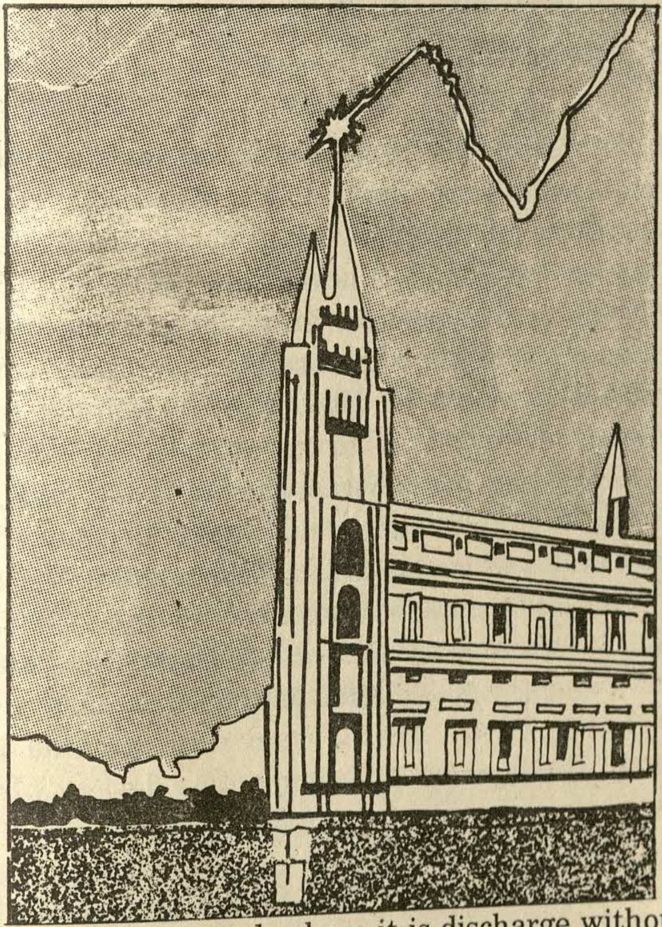
The phenomenon of magnetism was first put to use by man when the Chinese invented the magnetic compass. The Earth is surrounded by a magnetic field which has a north and a south pole. These magnetic poles are very close to the true geographical poles, and the needle of a compass will point towards the magnetic pole. The difference between magnetic north or south and 'true' north or south is called variation.

A piece of metal can have magnetism induced in it so that it too has a north and a south pole. The north pole of a magnet will attract the south pole of another magnet, so that they stick together. This is called magnetic attraction.

If a piece of soft iron is wound round with wire and an electric current is passed through the wire the metal becomes a magnet for as long as the current flows. This is called an electro-magnet, and is very useful as it can be used to operate switches and machinery. Very large electro- magnets can be used to pick up heavy metal objects, swing them round, and put them down.

Why do tall buildings have lightning conductors?

The energy and strength of a flash of lightning is enormous and can cause terrible destruction. Disasters can be avoided by making use of the fact that lightning will nearly always travel to the highest point of something that will conduct the electric charge to earth. If an electric conductor or cable is placed high up on a tower, or other tall building, it will attract lightning towards it and carry the



energy to the ground, where it is discharge without causing any harm. These are called lightning conductors.

Lightning occurs because the ground has a negative electric charge, while clouds have a positive electric charge. During certain weather conditions these charges increase and produce huge sparks, which are the flashes we see.

What are the most recent technological inventions?

There will be new inventions as long as the human brain continues to function. We seldom realize the importance of inventions at first. It is only later that they are found to have a practical application. In the case of radio, for example, a great deal of progress has been made since Marconi produced the first faint radio waves. His basic invention has been refined and improved to an extent that Marconi himself would not have imagined. Today, radio is still being developed and has many possible applications which are still to be exploited. Perhaps we shall never know the names of the scientists who today are busy perfecting existing inventions and making it possible for entirely new ones to be produced. These are the men who invented the maser, the laser and the computer - devices which have enabled science to make giant strides. The field of space technology - rockets, satellites and similar devices - has produced one invention after another in the past few years.

In present-day society there is an increasing tendency towards automation. This means that more and more machines are being built which can work effectively on their own. Automation is the result of man's wish to escape from the monotony of some kinds of work. Monotony can cause psychological problems, resulting in mistakes and inaccuracies, and present-day society cannot afford mistakes. The quality of a product must be first rate. An automatic machine can often work faster and more accurately than a man. It does not get tired and it costs less. In fact automation often seems the ideals solution, but it has many disadvantages. First of all, the machine is tending to replace man, who invented it. Opportunities for employment are becoming fewer, and the people who do work are no longer as skilled as they used to be. Today, much skilled work is undertaken by machines. For many people work is not longer the pleasure it used to be and some fear that man is losing his natural creativity. But invention will continue, even if only to solve problems created by the last invention. If automation gives people more leisure time researchers will come up with new ways of filling that time.

When were contact lenses invented?

The first contact lenses were made by A.E. Fick in 1887, but were not successful. During the early part of this century opticians tried to produce extremely thin shell-like lenses to fit closely over the eye. An impression was taken of the eye and a glass shell made which, with a suitable fluid under it, covered most of the eye. After 1938, plastic was used instead of glass, and about 1950 smaller lenses were introduced which covered only the cornea and floated on a layer of tears. These lenses, only 7 to 11 millimetres in diameter and 0.1 to 1 mm thick can usually be worn all day without being removed.

Besides being invisible, contact lenses provide a much wider field of vision than spectacles. They are more practical for use in active sports because they are not easily lost or broken, and they can be tinted for use as sunglasses. But contact lenses are not effective in all cases of eye trouble. They are also expensive, and some people find difficulty in learning to wear them.

As research continues, even smaller and more flexible lenses are being developed.

Where is rubber obtained from now?

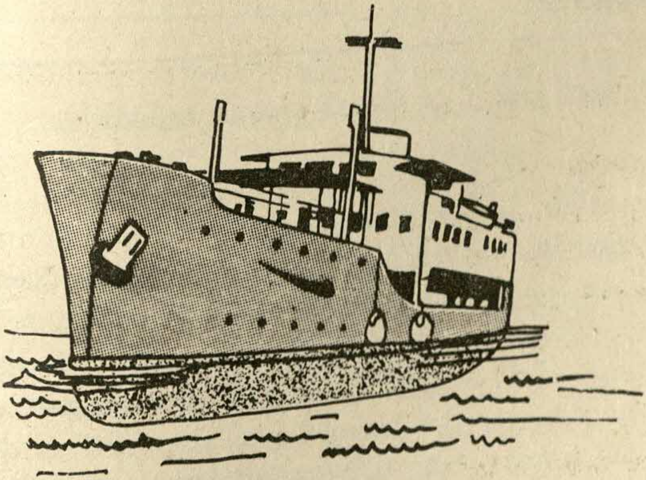
It no longer comes from South America, for the simple reason that cheaper rubber is now being produced elsewhere. This is because an Englishman managed to smuggle some rubber tree seeds out of Brazil in 1876, cultivating them in Kew Gardens, London, and then sending some to Ceylon.

The Far East provided ideal conditions, so much so that the succes of the plants there meant the end of the boom in Brazil, and therefore of the 'rubber barons'.

Now Malaya is the largest producer, with Thailand, Indonesia and Ceylon also figuring heavily. But today it is possible also to make good synthetic rubber - an invention of the Americans during the Second World War when rubber was scarce - and as this is cheaper to make than real rubber, there is more of it being produced.

How are ships weighing many tons able to float?

Ships stay afloat in spite of their great weight because they are hollow. For this reason they have a density which is less than that of water, and the total weight of the ship is less than the weight of the water that has been displaced. This produces pressure against the bottom of the ship which keeps it afloat.



How can a vacuum cleaner suck up gold?

Scattered over the seabed are large lumps of rock which contain valuable metals such as gold, iron, tin or platinum. These rocks are called mineral nodules.

There are plans to gather these underwater metals by sucking them up from the seabed through long tubes like huge vacuum cleaners. The tubes would be lowered and operated from ships on the surface. Barges would carry the loads of mineral nodules to shore.

Are atoms really the smallest particles?

The word 'atom' in Greek means 'indivisible'.

However we know that this term is not all appropriate, and the atom itself is made up of minute particles. It is very difficult to imagine this miniscule world and its components, but it is generally thought of as a miniature solar system, with minute 'planets' orbiting round a 'sun' which is slightly larger but still invisible to the human eye. This 'sun' is the nucleus which forms the centre of the atom. It is made up of one or more protons and several or no neutrons. Protons have a positive charge, whereas neutrons have none. Together they are called *nucleons*. A number of negatively charged particles, governed by the number of protons, revolve round the nucleus - these are the electrons.

Atoms can be combined in various different ways, and they can also be split, as is now well known.

On close observation, scientists found that particular types of atom emitted rays and particles at very high speed. Later it was found that working with these substances was highly dangerous, but it was vital to continue research on them as they promised to have important applications for medical science.

What is a millibar?

The millibar is the unit used to measure atmospheric pressure. The instrument which records the pressure is the barometer, first used in Italy, in 1643, by Evangelista Torricelli, an assistant to Galileo.

Pressure is measured in terms of force exerted on a unit of area. Thus the pressure of the atmosphere is given as about 14.7 pounds a square inch, or in metric terms a million dynes a square centimetre, of the earth's surface. Torricelli evolved the idea to balance this pressure against a column of liquid of which the height, density and value of gravity are known.

In 1953 the executive committee of the World Meteorological Society decided that "the millibar defined as a unit of pressure equal to 1,000 dynes per square centimetre, shall be the unit in which pressures are reported for meteorological purposes."

When are contour lines used on maps?

Contour lines are used when maps are designed to show the physical nature of the land. They do this by linking all points which are the same height above sea level. The width between the contour lines indicates the steepness of gradients or slopes in the area. The closer the lines are together, the steeper is the slope.

On physical maps giving the height of mountains, rivers, lakes and principal towns all areas between certain heights are generally shown in the same colour. This is known as layer colouring.

Other methods for indicating heights include relief maps moulded in plastic to the physical feature raised as on a model. Spot heights may be shown, but these merely give the heights above sea level of certain points of the map and it does not follow that the ground rises evenly from one point to another.

Very old maps have mountains drawn on them. Later ones have lines called hachures radiating from a central point, with longer lines to show gentler slopes. Another system is to show the form of the land by hill shading. But none of these methods is so effective as the use of contour lines.

How many kinds of radio telescopes are there?

Radio telescopes are made in different shapes and sizes. The most famous have a large dish for gathering in radio waves. Other have a line of small dishes. A computer adds up the radio signals gathered by all these dishes. Other telescopes have aerials set out in the shape of a cross.

What is the difference between organic and inorganic chemistry?

Many writers make a distinction between organic and inorganic chemistry. This difference was originally explained as follows. Organic links between atoms are those in which carbon is involved, whereas inorganic links are those in which, with few exceptions, the carbon atom is not present. This difference arose from the fact that there seemed to be a difference between the molecules which make up living being and the rest, such as water, gas, air, stone, earth etc. This distinction has become much more problematical since the creation of synthetic substances, which can themselves be considered a grouping of elements making up a living organism. Today there are thousands of organic substances to which the original difference between living and dead matter does not apply. An obvious example of such substances are the plastics, which rapidly became extremely popular, until, quite recently, people began to notice their many disadvantages. Some people even claim that the world will one day be buried under plastics waste, and they are not necessarily joking. Research must be done to teach how to break down substances as well as build them.

How does a radio work?

At a radio station music and voices are sent out into the air as invisible electrical signals. Our radio uses electric circuits to pick up the signals out of the air and turn them back into words and music. It then plays them loud enough for us to hear.

What is a Planetarium?

Getting to know the sky is not so difficult if you have help. It is easier if you can sit under a completely, clear, dark sky and have someone point out the main sky sights. You can do this in a planetarium.

Astronauts have studied the sky in planetariums. They have to know how to use the stars to find their positions on long space journeys.

Why does a balloon float?

For a balloon to float in the air, it must weigh less than the air around it. Balloons that float are often filled with *helium,* which weighs less than the air around us. If we blow up a balloon ourself, it will not float because our breath is the same weight as the air.

Which kinds of rock trap oil?

The earth has a very hilly surface. It is covered with high mountains and deep valleys. The surface of the Earth has been changing its shape for millions of years. Far below the ground, layers of rock twisted and folded. When they collided, great zigzag creases raised high hills and made deep valleys. Even today, the Earth is still changing its shape very slowly.

Soil and plants on the Earth's surface are gradually pressed down into a hard crust. They become new layers of rock. So the rocks nearest the surface are the newest. The ones that lie deep within the Earth are millions of years old.

The oldest rock were formed when fiery volcanoes poured out rivers of hot, bubbling lava which cooled into hard rock. Many millions of years later, when dinosaurs lumbered through the forests and swamps, new kinds of rocks formed.

The volcanic rocks were hard and smooth, but the newer ones were sandy and crumbly. They were full of small holes containing drops of water and bubbles of air.

As more layers of rock formed, these spongy rocks were pressed together. The air, water and remains of decayed plants and animals, trapped between the rocks, turned into a thick, dark, sticky mixture. This mixture is oil.

Who invented the first miners' safety lamp?

Sir Humphrey Davy produced his safety lamp in 1815, which protected miners from the danger of gas formed by decaying coal, known as firedamp. The safety lamp was like an oil lamp surrounded by gauze which formed a guard around the flame. If the wick was lowered, a blue flame would appear around the main flame if firedamp was present, and this would give the miner enough time to get well away from the danger area. Some safety lamps cannot be opened and others go out if opened. The Davy safety lamp has helped to save many lives.

How did photography develop?

When Francis Daguerre discovered in 1839 that an image could be produced on a sensitive substance by shining a light on to it, the principle of photography became an established fact. Later the process was modified and perfected, but what happens inside today's expensive cameras is exactly the same as in the first ever produced. Today, of course, sharper lenses are used to obtain a better picture; films are of better quality and easier to handle; but the system remains the same - a sensitive substance is exposed to light to produce an image. Fragile glass plates have been replaced by unbreakable rolls of film, but these have the same sensitive coating as before. Whereas before the lens aperture had to be opened and closed by hand, this is now done by a sophisticated shutter system, and recent developments in electronics mean that this can also be done automatically. We are capable now of taking photographs in poor light and in the dark - by means of flash light. Specialist photography can also be done in the dark without flash.

Today, colour photography is within everyone's reach, and threatens to replace black and white altogether. Photography has many different and valuable uses in society.

Why do roads slope down at the sides?

No doubt it would be much easier for car drivers if the roads were completely flat. It wouldn't be necessary to keep turning the steering wheel to stop the car from veering towards the edge of the road. The reason roads are made with a slight slope on either side is to carry rainwater away from the road surface. If this were flat, the rain would stay there, creating a nuisance and a danger to road users. The sloping edges encourage the water to flow away into the ditch or gutter and then to the drains.

What is a Radio Telescope?

Astronomers want to find out about all the other rays that things in space give out. They use radio telescopes to pick up radio waves coming from space. We cannot see radio waves. So astronomers do not look through a radio telescope. A radio telescope acts like the aerial on a radio at home. It picks up faint radio waves. If we listen to the noise from the stars, it sounds like a steady hiss. Each part of the sky is hissing loudly or softly. Astronomers can tell how much radio energy is being given out by different things in space.

Radio astronomers usually use a pen to trace the amount of hiss on to a piece of paper. The sound is often stored on magnetic tape, as in a tape recorder. It can be played back for study later. Some special telescopes have computers linked to them. The computers records the noise from different parts of the sky. It then draws a map of the radio sky.

What is oil used for?

Oil is needed to keep the modern world running smoothly. It is surprising how many things need oil to make them run and to keep them in good working order.

Most engines need oil to power them, others need oil to grease their wheels and make them spin smoothly without friction.

Many different companies are drilling for oil on land and sea. They turn this oil into petrol, and deliver it by tankers to all the petrol stations.

Before electricity was discovered, houses were lit by candles made from oil. There were also lamps, which burnt a special oil called paraffin. A long, cotton wick was soaked in paraffin and set alight.

It gave out a bright but smoky glow. The wick in an oil heater glows in the same way.

Oil is necessary to make electric power. In power stations it is burnt to make steam. Huge steam turbine engines whirr into action and make electricity. The electricity runs along heavy cables to light and heat our homes. Electricity also operates machines in factories.

Many toys are made of plastic. Plastic is made by mixing oil and chemicals together. Materials made in this way are called synthetic fabrics. Nylon, polythene and p.v.c. are synthetic fabrics. Clothes, bedclothes, carpets, curtains and even cushions are probably all made from synthetic fabrics. Paint on doors and walls may contain oil. Many soaps or medicines also have oil in them.

How do artificial satellites stay in space?

Powerful rockets carry artificial satellites beyond the atmosphere. Once they are in space, the rocket gives the satellite a great thrust of speed and sends it on its permanent journey. The satellite is subject to two forces - that supplied by the rocket which keeps it moving, and the pull of the Earth's gravity which keeps it from travelling further away into space - and these keep it in orbit around the Earth. Satellites are used for transmitting scientific information back to Earth, and for communication across the world.

When was rubber first used as an eraser?

The first recorded instance is again from the mid-18th century. Some pieces of crude rubber from South America were received by a British merchant, but he thought it useless and passed it on to his children to play with. They in turn gave a piece to a boy called Joseph Priestley who, it is said, then accidentally discovered its use as an eraser.

When was the sextant invented?

The sextant was invented in England in 1731 by John Hadley. Hadley's instrument is used mainly at sea to determine a ship's latitude, or distance from the Equator. Its invention laid the foundation of modern navigation with the aid of the sun and stars.

The instrument is so called because it is equipped with an arc which is usually one-sixth of a circle, or 60 degrees. It measures the angle of the sun's or a star's altitude above the horizon. As this angle varies with the distance from the Equator, the information obtained helps the navigator to calculate his position. All he needs in addition is the time, the date and the longitude which can be found by comparing local time with the time at Greenwich.

To operate the sextant, the navigator looks through its small telescope straight at the horizon. At the same time, an image of the sun is reflected by mirrors into the user's field of vision. When the sun is made to appear exactly on the horizon, the arm which moves the mirrors gives the required measurements to calculate the ship's position.

The handling of a sextant is generally referred to as "shooting the sun".

Why does a clock tick?

Do you wake up in the morning to the sound of a ringing alarm clock? The power for one kind of clock comes from a metal coil called a *mainspring*. The mainspring's movement is controlled by a set of large and small gears. As the edged of two of the turning gears catch together, you hear *tick-tock-tick-tock.*

What types of light sources do we know?

Our chief light source is the Sun. But this only gives light during part of the day. Man has sought artificial light sources since early times, and as a result of the amazing growth of technology in recent years, the number of known light sources has increased considerably. The simplest example is a burning match. Here light is produced by a chemical process. Friction causes a spark which ignites an inflammable material. Early fire users would try to keep the flame alight permanently because ignition was difficult. The fire could be used not only for light, but also for heat and for frightening away dangerous animals.

Our early ancestors used torches which had to be sprinkled at intervals with resin or oil to keep them alight. These torches had to be treated with great care, because they were used not only for lighting but also for heating and various other purposes. Much later, people had the idea of filling small earthenware containers with animal oil and floating a wick in it which could be set alight.
In some countries a particular type of oil was found - petroleum. This was a thick liquid which was found to give a much brighter light in the lamps of the time. Gradually, more and more elaborate lamps were devised, with adjustable wicks and shades which spread and softened the light by a process known as diffusion.

But while most houses were still using oil lamps of one kind or another, the most privileged households were already using gas for lighting.

In even richer establishments, people went on using candles, such as we still use today on festival occasions such as Christmas and Diwali.

How the Sun makes its energy?

At the centre of the Sun, energy is being made. It makes the Sun glow. The Sun is made of the gas hydrogen. Scientists think that the hydrogen is being turned into another gas, called helium. This change sends out tremendous heat and light.

Does this ever happen on Earth? Not normally. But we can make it happen. By exploding a hydrogen bomb, people can copy the way the Sun makes its energy. It is called a nuclear reaction.

But in a bomb the energy goes to waste in a moment. At the Sun's heart, energy is being made all the time. Every second, the Sun makes enough energy to send thousands of rockets blasting off into space.

At the moment we can only use this energy in clumsy bombs. If we could control it, we would not need oil or coal or gas to give us heat and light.
So scientists are trying to make machines which will copy the Sun. The machines are called fusion reactors. But so far they have not been successful.

What makes kite fly?

A kite is a very light wooden frame covered with paper. A long string is attached to one end. If we stand with our back to the wind and hold up the kite, the wind will pick it up and carry it into the sky. The force of the wind keeps the kite going higher and higher in the air.

Who built the first practical working model of a sewing machine?

Although Englishman Thomas Saint patented the first sewing machine in 1790, made from wood and with a needle which had a notch and not an eye, it was a Frenchman, Barthelomy Thimonnier, who finally produced the first practical sewing machine about forty years later. He used it for making uniforms for soldiers, but he was almost killed by angry workmen who thought that this machine would deprive them of their living!

How does a rocket works?

We can easily make a small model of a rocket. Get a balloon. Blow it up, and hold the neck tightly. The balloon is full of gas. The gas pushes to get out. It can only get out when you let go of the balloon's neck. The balloon's neck is like the nozzle at the bottom of a rocket. When you let go the balloon zooms around as the gas squirts out.

Almost the same thing happens in a rocket. The gas that builds up in the rocket can only get out through a small nozzle. The force of the gas squeezing through the nozzle pushes the rocket up.

The same thing happens if you turn a hosepipe on and let go of the hosepipe's end. The force of water squirting out of the pipe makes the pipe move about. The only difference is that the gases in a rocket are so hot that they give a much greater push.

A rocket is pushed along by gas escaping from inside it. Therefore a rocket works in space where there is no air. A rocket does not need anything to push against.

What is the Beaufort scale?

The Beaufort Scale is a scale for measuring the strength or velocity of the wind; the various strengths are given in numbers. It was formulated in 1805 by the British Admiral Sir Francis Beaufort, and has been periodically revised since then. It ranges from Calm, when smoke rises vertically and the wind is less than 1 m.p.h. to Beaufort Number 12 - a hurricane, when the air at sea is filled with foam and spray, and the wind exceeds 68 m.p.h.

How do you tell the time at sea?

On board ship, sailors tell the time by bells. The ship's bell sounds every half hour, ringing one stroke, then two, and so on until eight strokes sound. Half an hour later, this pattern starts again with a single stroke. Time at sea is measured in a different way from on land. The day is divided into six periods called watches. Each watch lasts four hours. The first watch starts at midday.

Sometimes the ship passes a bell buoy which warns of rocks or sand banks just below the surface. The bell sounds as the buoy bobs on the waves. Sometimes a special microphone in the hold of the ship picks up underwater signals. Submarine bells may be fixed to the sunken base of lighthouses to warn of shallow seas.

How did photography become popular?

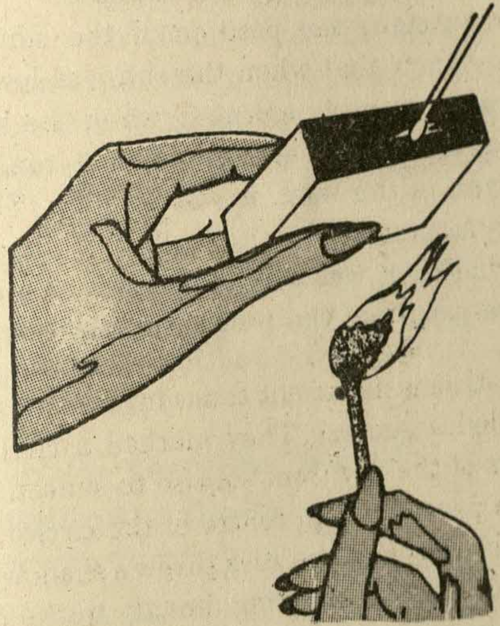
Most of us have watched a pavement artist making a lightning portrait of some passer-by, and thought admiringly, 'If only I could do the same!' And we might think that photography enables us to do just that, for with a camera we can record holiday scenes or beautiful landscapes and carry their image home with us to be looked at at our leisure. On closer inspection, of course, such images are bound to be a disappointment. We realize that the photo does not convey what we expected. However accurately the scene is reproduced, it is not the same as the one we remember.

The same is true of photographic portraits. Even if they are very faithful, they do not really 'speak' to us. Nevertheless, we continue taking photographs, partly because it is so easy. We need only press a button and then give the film to a photographic studio to be developed. Even if the result is no work of art, it serves as a reminder of the scene which we have recorded. On looking at it we may remember the pleasure it gave us, and this is where the magical charm of photography lies.

The other attraction of photography for the amateur can be developing and printing his own photographs. Although this can be time-consuming, and sometimes difficult, it is a rewarding hobby.

How does a match light?

The coloured knob on the top of a matchstick is the head, which is usually made up of phosphorous and other substances. Phosphorous catches fire easily



at a temperature of 50C. When a match is struck on the rough side of the matchbox, the friction causes the head of the match to become very hot. The phosphorous catches fire and lights the wood or card of the matchstick.

Because they ignite only when struck on the matchboxes provided and not on other rough surfaces, they are known as safety matches.

How can you tell the time by the sun?

Long before clocks were invented, people told the time by watching the position of the sun in the sky. They knew that when the sun was low in the east, it must be early morning, when the sun was overhead, it was midday, and when it sank below the horizon in the west, it was evening. This was not a very accurate way of time-telling. It was difficult to tell whether it was half past eleven or a quarter to twelve just from the position of the sun.

Mathematicians in ancient times invented a shadow clock called a sundial. They marked a circle with the hours of the day from sunrise to sunset. A thin stick was pegged in the centre of the circle. As the sun passed overhead, the stick threw a shadow across the face of the dial, pointing directly to the correct hour of the day.

How does a vacuum cleaner work?

An electric motor inside a vacuum cleaner turns a fan which pushes air out of the vacuum cleaner. Air from the room rushes in to take its place. The air that rushes in carries dust, dirt, and small objects. They are stored in a disposable bag that fits inside the vacuum cleaner.

How big is a rocket?

Big rockets are very heavy. They need many tonnes of fuel to push themselves. The Saturn 5 is the biggest American rocket. It is about 111 metres high. That means it is longer than a football field. Less than four metres of the rocket will come back to Earth.

The rocket weighs about three thousand tonnes before it takes off. When it has burnt all its fuel, it only weighs about 200 tonnes.

Who made the first non-stop tran-satlantic flight?

John William Alcock and Arthur Whitten Brown, who won the £10,000 prize money by flying a Royal Air Force Vickers Vimy bomber with Rolls-Royce Eagle VIII engines, from St. John's in Newfoundland to County Galway in Ireland, in May 1919. These airmen had to fight fog, instrument failure and bad storms on the journey, and for their great courage they were later knighted by King George V.

When will man be able to control the weather?

Since the 1940s scientists have discovered techniques by which several weather conditions can be controlled. For example, it is possible to prevent lightning by using an electrical earth to diffuse the electrical content of a cloud. The American scientist V.J. Schaefer has shown that it is feasible to produce greater concentrations of ice in clouds than occur under normal conditions.

Weather experts already are taking advantage of these discoveries to increase snowfall on mountains for winter sports, to prevent damaging hailstones and to moderate, or even prevent, the development of dangerous storms. Scientists are now able, in some cases, to make a cloud burst to produce rainfall over parched areas.

These local efforts may lead the way to large-scale weather control. But before then scientists may have to learn to cope with the damaging effect of air pollution on weather conditions.

What is a laser beam?

In 1961 it was discovered that when certain substances were exposed to light at a particular frequency they would emit a beam of light at the same frequency, but with far greater power than could be obtained by any other method. When the materials used are glass or crystal, this light is known as laser light. As it is only of a single wavelength, laser light can be transmitted over long distances in a highly concentrated beam which has a great deal of energy. Laser beams are used for boring narrow holes in diamonds or for cutting other very hard materials, also for operating on the retina of the human eye and for making exact measurements over long distances. They can be very dangerous if they enter into contact with the human body. Laser beams have an important application in the field of telecommunication. Since they can be directed very accurately, transmission and reception are far more clear and precise than with other forms of wave.

How is a record made?

We know that sounds can be turned into electrical signals. To make a record, music and voices are turned into electrical signals. Then those signals are fed into a machine that turns them into a series of wavy grooves that are imprinted on a plastic disc. Many, many copies are made of that disc. We call one of those copies a record.

What were the first shoes like?

They were often knitted or sewn stockings; later these were made from animal skins and in bad weather covered by a simple wooden sandal. In the warmer countries, sandals with leather thongs were worn from the earliest times. There was little change in footwear until the seventeenth century when the first heeled shoes came into being, trimmed with lace and ribbons. From then on heels have remained important. Later leather boots were invented. In modern times shoes are made from wood, rubber, cloth and synthetics as well as from leather.

Who works on an oil rig?

The oil rig is like a small island far out at sea. Strong gales lash the steel girders. High waves break fiercely against the legs. Sometimes a sea mist creeps in and cuts off the rig from the supply ships which bring food and equipment.

The cranes and drilling equipment are on top of the platform of the oil rig. The crew's quarters are below deck. The rig hums with activity day and night. Work goes on twenty-four hours a day in shifts.

In their sleeping quarters, the workmen, who are off-duty, play cards, read books or watch films. Their work is exhausting. After a few weeks on the rig, they fly home by helicopter for a week's holiday.

Everybody on the oil rig is part of a team and has an important job to do. There may be as many as sixty men working on the oil rig at a time. The drill superintendent is in charge of the rig. He organizes the drilling programme with the help of geologists, scientists, weathermen and engineers. He gives orders to the foremen, who are known as toolpushers. They, in turn, organize the gangs of workmen. The workmen are known as roustabouts.

The divers make daily underwater checks to the rig. They clean the rust from the girders and scrape barnacles off the pontoons and legs.

How does a record player work?

The needle on the arm of our record player reads all the grooves on a record, and turns them back into electrical signals The record player turns those electrical signals into sounds and words again, and makes them loud enough for us to hear.

Who is in charge at the steelworks?

At the steelworks, shining steel tubes, bars and smooth sheets are made from rocks of iron ore. It is a hot and noisy place. Huge furnaces are filled with iron ore and coke and as the metal heats and melts, it glows orange and yellow, and finally pours out into a mould in a running stream of white-hot liquid.

In the mould, the iron cools into a rough shaped bar. It must now be rolled, pressed and shaped by great machines controlled by computers. The computer has been given a programme which lets it know what size the bar should be. The computer decides how fast the bar should pass between the giant rollers, and how firmly they should squeeze it. It sends signals to the machines to make them press harder or roll faster so that the steel bar will come out the right shape.

The same computer can do other jobs at the steelworks. Just as you can make a model to show you how a ship or a plane works, the computer can make a model of a steel bridge or steel crane. It doesn't actually make a small model, but it can make detailed plans, showing exactly what steel bars will be needed, how long and how tough they must be, and where they will need to take plenty of strain. It may show its plans on a screen to help the scientists and engineers at the factory.

As well as helping with steel making, the computer may also be used to calculate the wages of the steelworkers. It also keeps a check of all the stocks of metal and makes sure that there is enough steel being made to supply all the customers.

What are weather centres?

These are places, set up in many parts of the world, where information about weather is collected and classified on a regional and worldwide basis. The information - taken from weather balloons, oceangoing ships and planes, satellites, weather-ships and weather-stations based on land - has proved invaluable in the making of maps and weather-charts. Readings are taken everyday. In main centres, such as airports, readings can be taken as often as once every thirty minutes.

Who can be a spaceman?

The first astronauts were all aeroplane pilots. Later, other men become astronauts. They were scientists and engineers. They had special jobs to do in space. The first scientist to go into space was a geologist. He knew a lot about rocks. He went to the Moon.

No one knew quite what to expect when the first men went into space. So they took great care to choose only the very best men. Everyone was given a tough medical test. If there was the slightest thing wrong with them, they could not become astronauts. The chosen men were then trained very hard.

What is holography?

Holography has been known since 1948. It is a kind of photography which creates a three-dimensional image - the hologram. Holograms have been used in scientific experiments since 1968. We all know that a certain amount of light is needed in order to produce an image on a photographic plate. As laser beams are very powerful they can be used to produce photographs with very short exposures. This means that it is possible, for example, to photograph the very short vibrations of a metal plate. If the ordinary light reflected by an object is mixed with a laser beam, an image can be produced on a photographic plate which when it is illuminated again by a laser beam after exposure will make the object appear in three dimensions. The possibilities of this new process have yet to be fully exploited, since laboratory research is very expensive. Holography is still too complicated to be used regularly on a commercial scale.

Why does a compass point north-south?

When the magnetic needle of a compass is allowed to move freely it will automatically place itself in line with the earth's magnetic field, one end pointing to the magnetic North Pole while the other indicates the South.

Natural magnets, such as loadstone or pieces of iron which have been touched by a loadstone, are to be found the world over. It was the discovery that loadstone would always place itself so as to lie in a magnetic north-to-south position that led to the invention of the magnet.

During the 15th Century It was realized that the magnetic North Pole and the geographic north pole were not exactly in the same place. The small angle between the two is known by seamen as "the variation". Some experts have claimed, however, that the Chinese were already aware of the existence of variation as early as the 11th Century. Again, in the 15th Century, it became apparent that the earth itself was a great magnet.

How will people get to the stars?

If we built a big enough spaceship, whole generations of people could live and die on board. There would always be new children to grow up and take over the ship. Another idea is to freeze people. They would be unconscious but alive during the flight to the stars. When the ship got to a star, they would thaw out and work the spaceship. But by the time they got back to Earth it would be very different. Thousands and thousands of years would have passed.

Until spaceships go faster we will have to use robot probes to reach the stars. They will be the first step towards exploring the Universe.

How does a tape recorder work?

Tape recorders have two wheels, or reels, of tape, which store electrical signals. In a cassette recorder, both of those reels are inside the plastic case. The tape recorder does two things. It makes the tape move from one wheel to another. It also changes words into electrical signals and changes those signals back into words. When we *record* a voice or music, the machine puts signals on to the tape. When we *play* a tape, the recorder reads the signals and changes them back into words and sounds for us to hear.

How are bells made?

Bells are made in a foundry using methods that have not changed much for thousands of years. Foundries were once kept busy making cannons and large weapons, as well as bells. Today, there are only a few foundries left.

The bell founder first makes a clay, sand and mud model of the bell, called a core. Ensuring this is completely dry, he smooths the outside to a shiny gloss with a coating of china clay. He then makes an exact copy of the bell, called a dummy. He models this in clay and wood, pressing it tightly over the core. When dry, a third outer layer, called a cope, is packed over the dummy.

To make a metal bell, copper and tin are mixed together in special proportions, and heated to a very high temperature until red hot and liquid, or molten.

The molten metal is poured through funnels into the mould between the core and the cope. When the metal is cooled, the cope is chipped off, the bell lifted from the core, then cleaned and polished. Much of the skill in bell-making is in the final shaping and tuning. When the bell is beaten by a clapper, the strike note must ring out pure and clear.

The three layers are then separated. The dummy is thrown away, as only the inner core and outer cope are needed. The gap left between them forms the mould for the bell.

The bell is tuned on a lathe. As it spins round, a machine gently files away fine layers of metal from the inside, until the tuner hears that the bell produces pure notes.

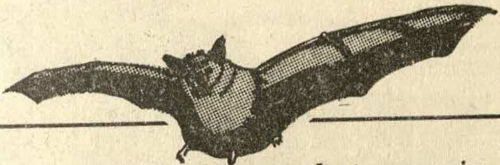
Many bells are inscribed with the name of the foundry and date they were cast. They sometimes carry a verse, a quotation or some dedication.

What is light?

Light is something which we perceive with our eyes. Scientists tell us that it is made up of electro-magnetic rays. Biologists explain that 'everything which is registered by the eyes is light'. We know that man possesses an auditory world and a visual world. A blind man does not have the latter, but with the help of various devices or pieces of optical apparatus, he can now lead a more or less normal existence.

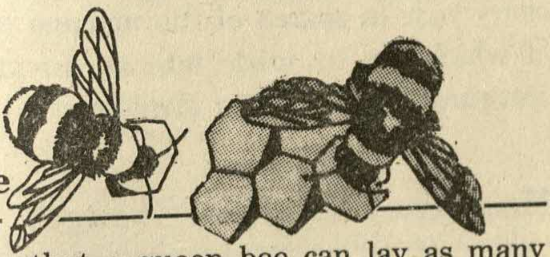
Chapter 5

Amazing Facts



Bat

Have you ever wondered how a bat sees in the dark? Well, it has a sort of radar system, like a plane does. The bat makes lots of tiny squeaks that humans can't hear, which echo back to it from solid objects like trees and houses. The pitch of the sounds tell the bat how big the object is and exactly where it is, so that it can stop itself flying straight into things.

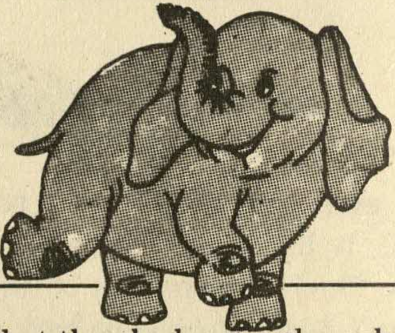


Queen Bee

Did you know that a queen bee can lay as many as fifteen hundred eggs a day? In fact, this means that if the queen lives for a long time, she can lay a million eggs in her lifetime.

Mole-Expert Digger

A mole deserves a medal for the amount of digging it does. Just one mole can tunnel over two hundred and twenty-five feet underground in a single night.



Elephant

Did you know that the elephant is the only mammal to have four knees?

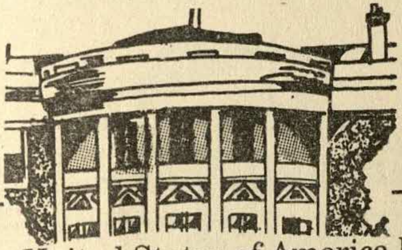
Elephants in a place called Pongolo, Africa, migrate every year in search of the umgana tree, the fruit of which can be made into an intoxicating drink. Imagine all those tipsy elephants!

How They Carried Change?

If you have a lot of change to carry around in your pockets; it's sometimes very heavy and awkward. Spare a thought, then, for the people of the Yap Islands, who used stone circles as money. Some of these 'coins' could be six feet across, so that it took four people to lift one.

Exporting Lions

Did you know that Britain's Windsor Safari Park exports lions - to Africa?

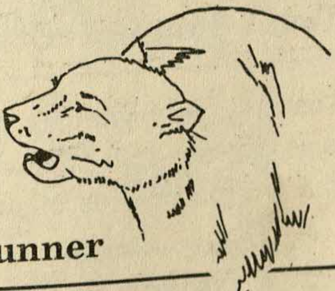


White House

The President of the United States of America lives in the White House. But why was the house first called White? In 1814 there was a fire in the building, and the walls were stained brown with smoke and flames. Later, the stains were hidden when the house was painted white, and the White House it has remained ever since.

Valuable Salt

You probably don't think twice about sprinkling salt on your food. But in ancient Mexico, salt was considered so valuable that the people worshipped a salt god.



Polar Bear-A Fast Runner

A polar bear may look clumsy and slow, but when it's chasing something on the ice it can reach speeds of some twenty-five miles an hour!

Snails-Slow Movers

Snails move very slowly, don't they? But even their slow pace tires them out. Snails have been known to sleep for anything up to three or four years at a time.

Smith-A Common Surname

Is your surname Smith? If it is, you're not alone. There are enough Smiths in England and Wales alone to fill the Wembley Stadium eight times over.

Tea-A Popular Drink

Tea is a very popular drink in Britain. In fact, it is so popular that the average British person drinks about nine pounds of tea a year!

Lord Nelson-A Great Sailor

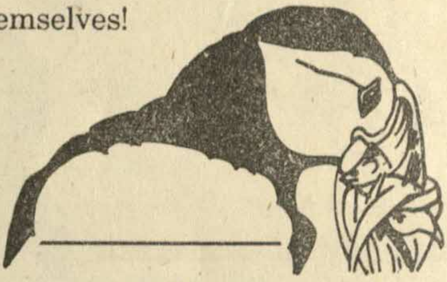
Did you know that Lord Nelson, Britain's greatest sailor, suffered from sea-sickness all his life?

Discovery of America

Everyone knows that America was discovered by Christopher Columbus. But not many people know that when he arrived in America, he was actually looking for the Spice islands of the East Indies. He hoped to find them to show people that the earth was round, and not flat as was generally believed. Instead, he found a whole new continent.

Kangaroo

Have you ever seen a kangaroo? Some of them are very big, aren't they? But when they are born kangaroo babies, or joeys, are only one inch long. No wonder they are grateful for the mother's pouch to carry them around in until they are big enough to look after themselves!



Puffin

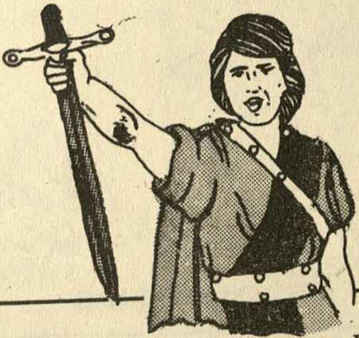
A puffin eats as much food as it weighs every twenty-four hours, and yet it never seems to get fat. It's not fair....

Saint George

On April 23 each year the people of England celebrate the festival of their patron saint, George. But did you know that St George was not English, but a soldier from Palestine in the Holy Land, and he probably never came to England at all?

Sparrows-Hatching

Having babies isn't all fun, you know. Take a pair of sparrows, for example. During the three weeks between the hatching of the eggs and the time when the youngsters make their first flight, the parent sparrows make over five thousand hunting trips for food for their greedy fledgelings.



Pepper

Pepper was also considered to have a very high value. When Alaric, king of the Visigoths, attacked and destroyed Rome in the year 408 he demanded three thousand pounds of pepper as part of the city's ransom.

Names-Their Origin

Why do we give things certain names? Take the metal nickle as an example. The word nickel comes from a German word, and was used because the metal is so hard to work with. The German word from which we have nickel means *imp*!

Albatross Can Glide

Did you know that an albatross can glide for up to six days in mid-air without beating its wings, and that it can take a nap while doing so?

The Brave Pigeon

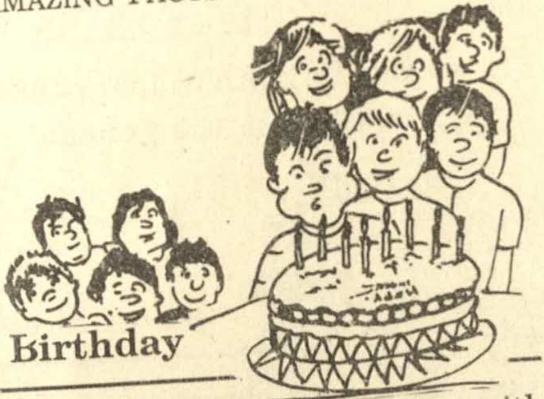
Here's a story of a brave bird. A pigeon was awarded a medal in the First World War for carrying vital messages through the gunfire in France.

Sea Otters

Sea otters are extremely clever animals. To get at the shellfish which they eat, the otters lie on their backs in the water with a stone on their chests. Then they pick up the shell and bash it against the stone to break it!

Volcano Eruption

In 1943 a peasant in Mexico was ploughing his field when he heard a rumbling noise and saw smoke rising from the ground. Frightened, he ran away. By the end of the same week, there was a volcano one hundred and fifty metres high in the middle of the field, and it was still growing.



Share Your Birthday

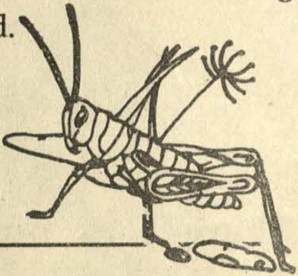
Did you know that you share your birthday with about nine million other people around the world?

Population of the World

Think how many people there are in the world... thousands of millions! Then think of their finger-prints - no two people's fingerprints are exactly the same. This is why fingerprinting is such a help to the police when they are investigating crimes; if they get a good set of fingerprints on a clue then it won't be long before they have caught the criminal.

Grasshopper-Cicada

There is a type of grasshopper called a cicada, which can live for almost seventeen years. But the poor cicada only spends five weeks of that time in the sun making its shrill call. For the rest of that long time it is asleep in the ground.



Locusts

Have you heard about swarms of locusts eating everything within sight? Well, half a million locusts, which is only a very small fraction of a swarm, eat as much food in a day as two hundred and fifty people do!

Duelling

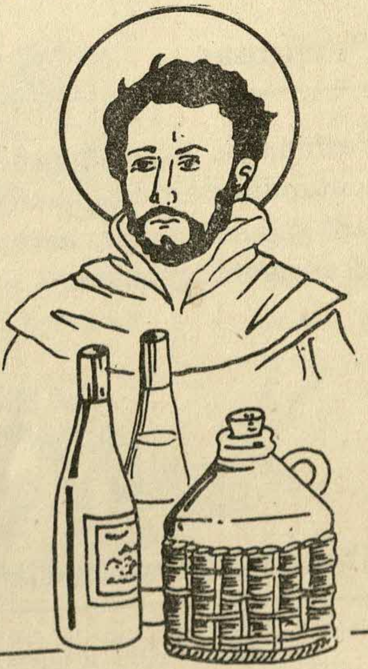
There have been lots of films where the hero and the anti-hero have a duel, sometimes with swords and sometimes with pistols. Duelling is now illegal - perhaps because between 1601 and 1609 more than two thousand Frenchmen of noble blood were killed in duels!

Hair

Did you know that your hair grows more quickly at certain times of the day than at others? In the middle of the morning and in the early evening, your hair grows faster than at other times, but the difference is so small that you wouldn't see it if you spent all day in front of a mirror!

Superstitious Chinese

Despite being so clever, the Chinese were also very superstitious. Because they believed that evil spirits could fly only in straight lines, they used to build their homes with rounded corners to confuse the spirits!

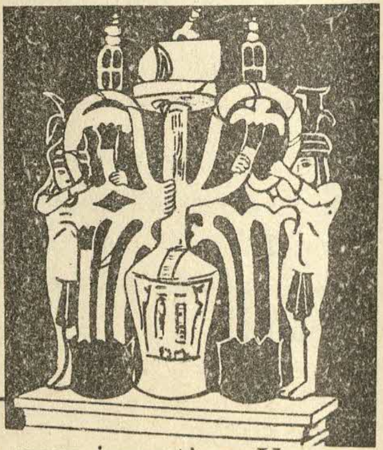


Saint Vincent

The patron saint of wine Saint Vincent, never touched a drop of alcohol all his life.

Women Punished for Makeup

Lots of women wear make-up today. But in 1770 a bill was put forward to the British Parliament which proposed that women using makeup should be punished for witchcraft!

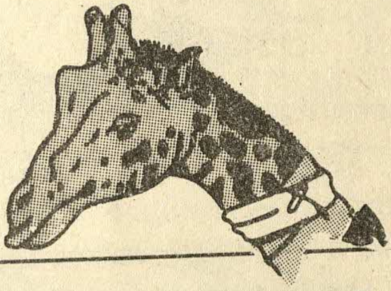


Perfumes

Perfume is by no means a new invention. Vases containing perfume, nearly 5,000 years old but which still smelled sweet, have been found in the tombs of ancient Egyptians.

Shrinking by Age

Did you know that people start to shrink after the age of about thirty? They don't shrink very much though, so your parents aren't likely to vanish!

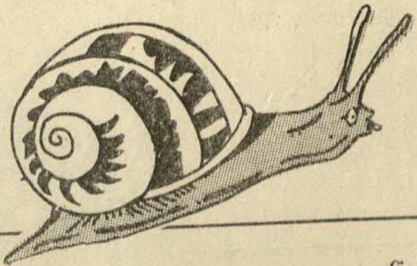


Giraffes

Giraffes have very long, elegant necks. But that can sometimes lead to trouble. Because giraffes can't cough, they very often get throat infections - can you imagine a sore throat that long?

Dogs

Most people like dogs. But in Japan and the USA they have taken things a little far. There, there are restaurants especially for dogs!



Fierce Snails

You might not think that snails are very fierce. But a snail can have as many as twenty-five thousand teeth! Imagine being bitten by one!

Snake Charmer

You may have seen films of a snake charmer playing music to a snake in a basket and making it dance. In fact, the snake can't hear the music, or anything else for that matter. Snakes are deaf! When a snake charmer charms a snake, what he does is to tap his foot on the ground and sway about. The snake moves in time to the vibrations and watches the charmer so closely that it sways as he does.

Penguins

Penguins look very odd on land, waddling about. But underwater, a penguin can reach great speeds — enough speed in fact to be able to leap seven feet into the air!

Pig

If you ever want to make friends with a pig, sing to it. Pigs are very fond of music.

This Horse Is Not Dead!

Rodger-The Horse

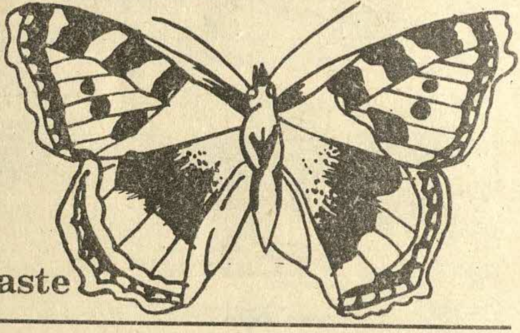
A horse named Rodger so alarmed passerby by sleeping on his back with his legs in the air and his mouth open, that his owner Mr Davis put up a large sign in Rodger's field saying "This horse is not dead"!

Pigeons-Message Carriers

Did you know that despite all the complicated machines for relaying messages which are available today, the British army still trains homing pigeons for use if all else should fail?

Mozart

The famous composer Mozart wrote his first opera when he was only nine years old. He did it on the request of the Emperor of Austria, who had heard him play several times before.



Butterflies-Taste

Did you know that flies and butterflies can taste with their feet?

Female Butterflies Use Perfume

Female butterflies have a store of perfume which they use to attract the males. This store weighs about one ten thousandth of a milligram, and the females only use a tiny fraction of that. Even so, the male butterfly can detect the perfume from a distance of seven miles!

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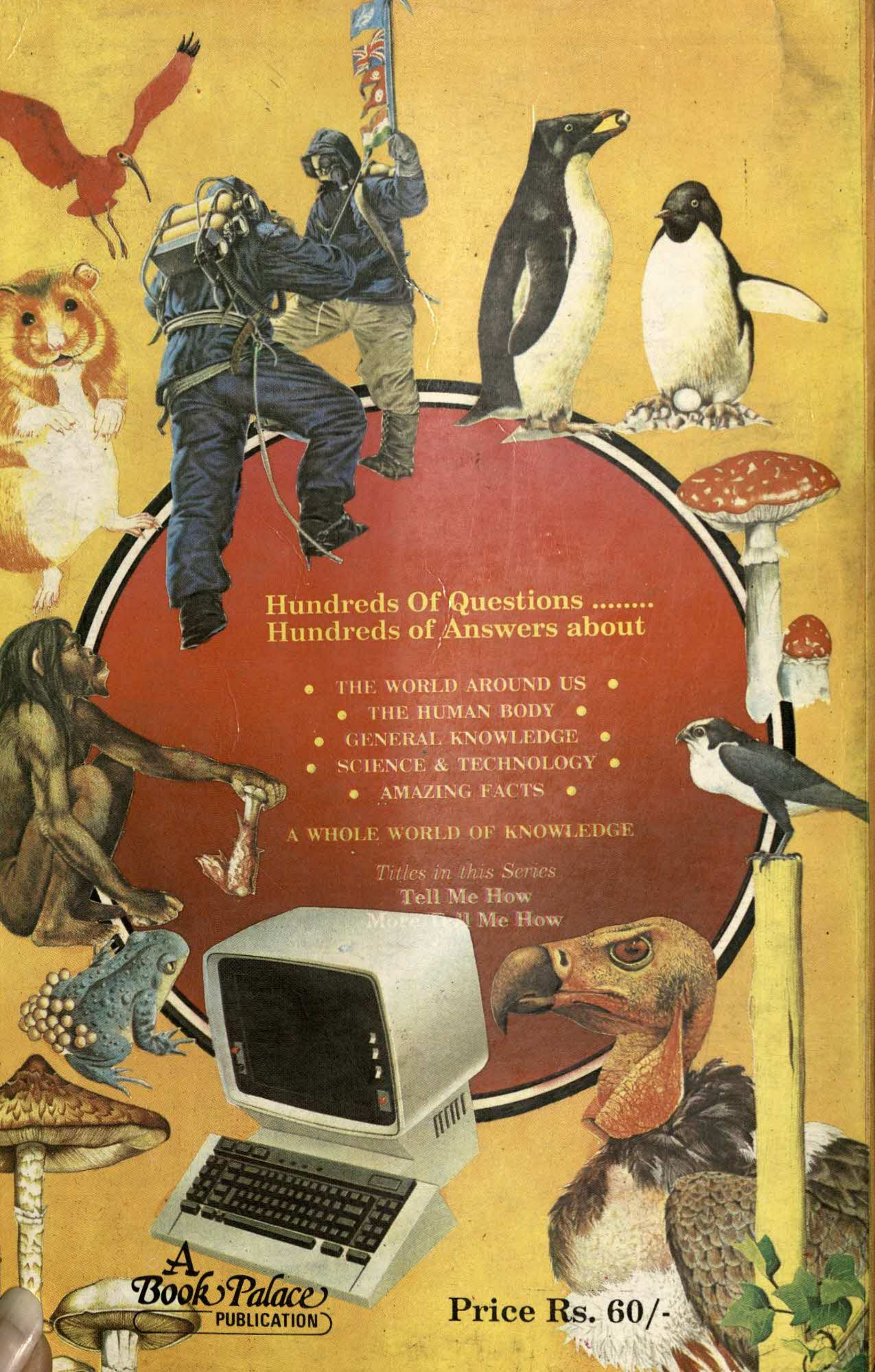

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